Climate Resilience Guidelines for BC Health Facility Planning & Design

October 2020 – Draft V1.0

ACKNOWLEDGEMENTS

This living document is the culmination of more than a year of multi-sector collaboration to develop practice-based guidance for BC Health Authorities: an industry Task Force to develop resilient design strategies with low carbon, seismic and pandemic synergies; a Health Authority Working Group to validate proposed approaches; and, an interdisciplinary Advisory Group to contextualize development. Thank you for your contributions.

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ACRONYMS & GLOSSARY

<To be completed upon review of draft V1.0>

1. INTRODUCTION

1.1. Health Facility Planning & Design in a Changing Climate

Health facilities and operational services across British Columbia are already facing challenges from climate change in the form of warmer temperatures, shifting precipitation patterns, and more frequent and severe weather events (e.g. heat waves and wildfires). Despite global best efforts to limit greenhouse gas (GHG) emissions (i.e. climate change **mitigation**), mounting scientific evidence makes it clear that these trends will only intensify in coming years. This is anticipated to lead to increased strains and disruptions for health facilities, with cascading impacts on patients, health staff, and communities of care as a whole.

Health facilities developed today will experience climatic conditions that are drastically different than those of the past, including **ongoing strains** (e.g. steadily warming temperatures) and **acute shocks** (e.g. flash flooding events) that challenge health service delivery. However, with this challenge comes the opportunity to be proactive about addressing and managing climate change risks (i.e. climate change **adaptation**) and to enhance facility **resilience** so that the Provincial Health Authorities can:

- ✓ Anticipate and reduce exposure to climate-related hazards;
- ✓ Maintain critical operations and essential services in the face of a shock or stress;
- ✓ Safeguard the health and well-being of patients and staff;
- ✓ Reduce risk of strains, failures, closures, or evacuations;
- ✓ Consider cascading impacts between systems or scales; and
- ✓ Return to normal operations in a fast and efficient manner following an event.

The *Climate Resilience Guidelines for Health Facility Planning and Design* ('Resilience Guidelines') are intended to provide a roadmap for the Health Authorities, project Design Teams and other health system stakeholders as they navigate this transition.

1.2. Leading the Way

Climate action policies, legislation and mandates support the health system[1] to address climate change in a variety of ways. Population and public health, emergency management, monitoring and surveillance, facilities management and others are working to better understand, reduce and manage climate risks to people, assets and infrastructure, and health services in our new climate reality.

Climate Policy & Legislation

- The Federal *Pan Canadian Framework on Clean Growth and Climate Change* provides guidance that different levels of government will collaborate to address climate change-related health risks.
- This is confirmed in the Provincial *Climate Leadership Plan*, through which public sector organizations (PSO) are mandated to produce 10-year plans for climate mitigation and adaptation.
- In December of 2018, the Provincial Government released *CleanBC*, its plan to reduce greenhouse gas emissions from buildings, transportation, and industry. This reaffirmed the need for public sector

[1] **WHO Guidance for Climate Resilient and Environmentally Sustainable Health Care Facilities** (World Health Organization, 2020)

organizations to demonstrate leadership on climate action. The Province is currently preparing a complementary adaptation strategy (scheduled for release in December 2020), which further emphasises the need for public sector organizations to lead in developing plans and actions to reduce climate risks, and to report annually on progress.

- The *Climate Change Accountability Act*, updated in 2019, directs the public sector to demonstrate leadership in reducing greenhouse gases and climate risks. It requires the Minister of Environment and Climate Change Strategy to report on plans, actions and progress in reducing climate risks.

BC Health Authority Mandates

- Health Authorities are directed by the Ministry of Health to "contribute to address climate change, through working on human health vulnerability assessment and adaptation strategy" in the 2019/20 and 2020/21 bilateral agreements.
- In 2020, the Ministry of Health provided further direction for Health Authorities to "ensure your organization plans to align operations with targets and strategies for minimizing greenhouse gas emissions and managing climate change risk" and to "…be prepared to work with government to report out on these plans and activities"[2].

1.3. Introduction to the Resilience Guidelines

The purpose of the *Climate Resilience Guidelines for Health Facility Planning and Design* is to better enable the planning and design of new health facilities that are equipped to deal with the present and increasing challenges of climate change, including extreme heat and humidity, air quality impacts, flooding and extreme events.

The Resilience Guidelines apply to all new construction, major redevelopment and retrofit Projects that require Business Plan or Business Case approval, are valued at over $2 million, and exceed a minimum threshold of climate exposure, sensitivity and/or adaptability.

The intent of the Resilience Guidelines is to guide the planning, procurement and implementation phases of the health facility lifecycle, which is guided by the goals, objectives and principles outlined in Table 1. Key elements for contract, procurement and project evaluation documents are provided to help establish a baseline for Projects, and to ensure that a standard set of information is utilized by Proponents.

The Resilience Guidelines are not intended to serve as a 'one size fits all' prescription for all Health Authorities, but rather to provide information for each Health Authority to utilize as appropriate.

[2] 20/21 Board Mandate Letter

Table 1: *Goals, objectives and principles of the Resilience Guidelines.*

Goals	• Better understand, reduce and manage the impacts and risks of climate-related hazards (e.g. extreme heat, severe storms, flooding) to health facilities • Raise the bar on our knowledge and capacity • Co-create new choices and opportunities with industry partners
Objectives	• Enable project teams and proponents to work with a clear frame of reference • Provide sufficient information required by consultants to assure clients that resilience can be embedded from concept to end-of-life • Better ensure decision-makers understand value add and trade-offs
Principles	• Consider multiple levels or scales concurrently • Anticipate interruptions and change • Allow for iteration and continuous improvement • Emphasize 'no-regrets' options and implementation pathways • Prioritize simple, flexible and durable design strategies • Cultivate synergies between strategies • Complement ongoing efforts to reduce emissions, seismic and pandemic risks

1.4. Using These Guidelines

The Resilience Guidelines are designed to be easy to use for all involved parties, including Health Authorities, Compliance Teams, and Project Proponents (both bidding and successful). The general roles, phases involved and areas of responsibility for each party are described in Table 2 below.

Table 2: *Roles, phase and areas of responsibility for parties involved in the Resilience Guidelines.*

	Role in Process	Phases Involved	Area of Responsibility
Health Authority	• Define resilient design objectives, and the levels of performance required of the Project	• Lead Site Plan, Facility Plan • Support other phases • Indicative Design	• High Level Master Plan, • Concept Plan • Business Plan • Climate Hazard Exposure Screen • Preliminary Climate Risk Assessment
Compliance Team	• Define the levels of performance required of the project, validate requirements, audit compliance	• Support Procurement Phase and Implementation Phase	• Preliminary Climate Risk Assessment • Climate Risk Assessment • Climate Resilience Compliance Audit
Proponents	• Propose design options for the project	• Procurement Phase • Schematic Design	• Climate Risk Assessment
Successful Proponents	• Design and build the project	• Detailed Design • Construction	• Climate Resilience Compliance Audit

How should the Resilience Guidelines be used?

The primary steps involved in improving facility resilience and the key roles and expectations of each major actor involved are summarized in the Process Diagram (Figure 1), and fall under one of three broad phases: **Planning and Design**, **Procurement** and **Implementation**.

Phase 1: Planning & Design

This section provides an overview of planning and design in relation to the facility delivery lifecycle, focusing on the early stages where it is most cost-effective to reduce risk and where it is most feasible to maximize co-benefits. It also introduces the Climate Risk Assessment process, which is described in detail in Section 6.

Phase 2: Procurement – Project & Consultant

This section provides an overview of key components and competencies required to enable climate risk assessment in planning and design. It outlines make clear expectations of Compliance Teams, Proponents and Consultants. The text within this section can be used to populate requests for proposals, contracts and scopes of work.

Phase 3: Implementation – Resources & Resilient Design Strategies

This section provides descriptions and links to resources to inform the Climate Risk Assessment process, along with recommended resilient design strategies to serve as a starting point for Design Teams.

Companion Documents

The climate resilience work being guided by this document is occurring in concert with a number of other related Health Authority initiatives. Key documents to be considered as companions to the Resilience Guidelines include:

- Establishing Design Conditions for Climate Resilient Planning and Design of Health Facilities in British Columbia (reLoad Sustainable Design Inc, 2020)
- Green Design for Climate Resilience & Well-Being (UBC Collaborative for Advanced Landscape Planning, 2020)

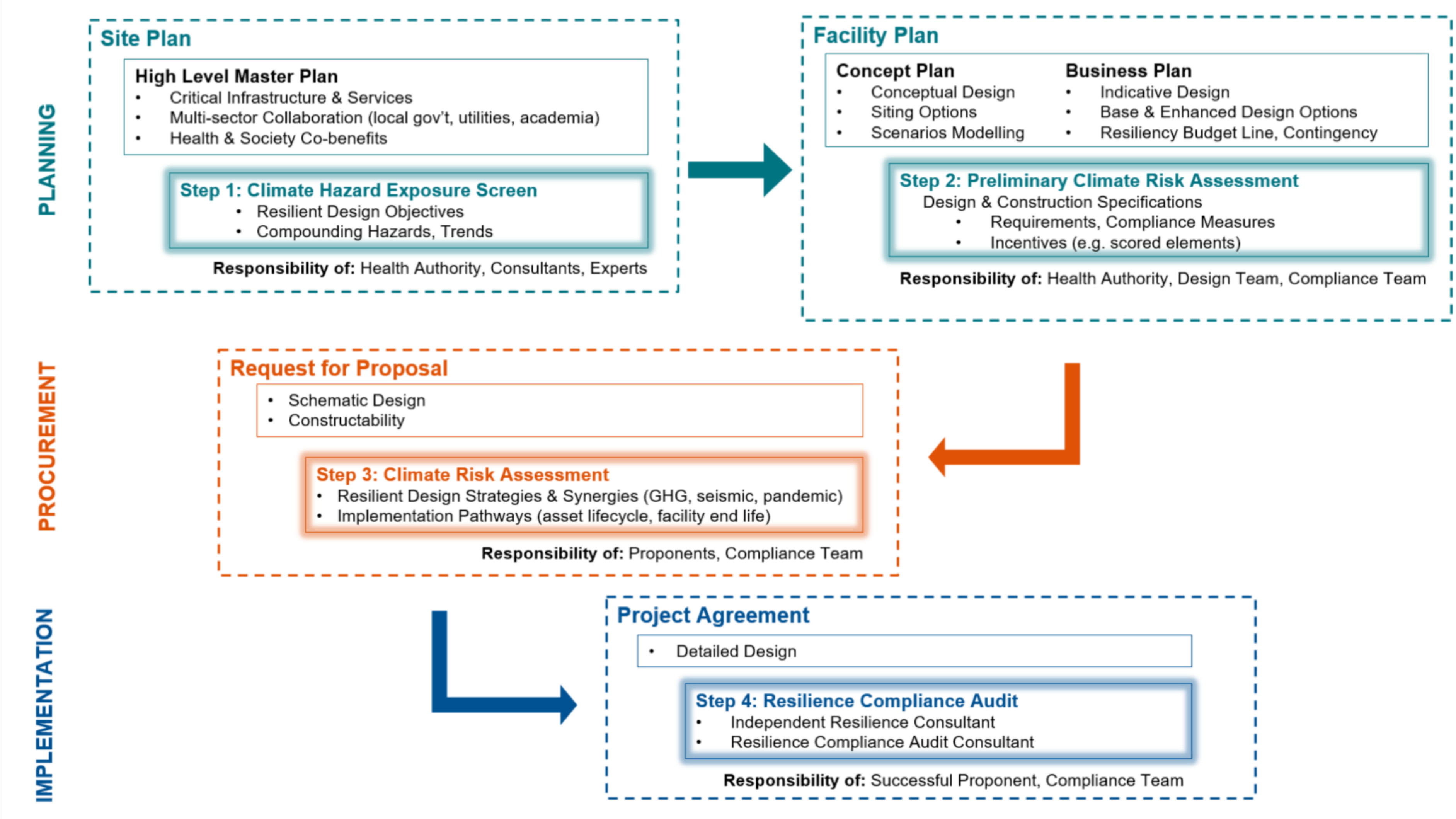

Figure 1: *Process Diagram for projects following the Climate Resilience Guidelines for Health Facility Planning and Design.*

2. BACKGROUND

2.1. Our Future Climate

Health care facilities in the region face a multitude of challenges from a changing climate, including an increase in overall temperatures and extreme heat events, wildfires and air quality concerns, and more frequent and intense storm events. Leading climate science is clear that greater variations, anomalies, and extremes in temperature and precipitation are highly likely to occur. For example:

- **Increasing daytime temperatures** will be experienced at all facilities. By 2080, the number of days warmer than 25°C will be four times greater than in the past, requiring an increase in operational costs for cooling.
- **Days above 30°C** will increase dramatically at every site. Facilities may experience a surge in patient visits due to heat stress.
- **Warm nights** will increase significantly by 2080. The ability of patients to heal may be reduced.
- More frequent and intense **storms** will occur, and flood risks will increase with 1m **sea level rise** by 2100.

There are many climate-related hazards that can be considered, with the importance of each depending on the project-specific characteristics such as location. The set of hazards deemed to be of greatest relevance to projects in BC and explored within the Resilience Guidelines includes:

1) Warming temperatures and extreme heat;
2) Air quality impacts;
3) Flooding;
4) Power outages; and
5) Chronic stressors, specifically water shortage and drought, moisture and humidity, freeze/thaw cycles, snowfall, and wind.

Underlying these risks is the constant risk of seismic events and pandemic events. While these are not climate hazards, they have the potential to compound with the climate risks above. It is therefore prudent to consider potential synergies and conflicts of designing for climate resilience and designing for facility resilience more broadly.

2.2. Risks Posed to Health Facilities

Health care facilities need to prepare for both direct and cascading impacts of climate change and how these will hinder the ability to provide community care. Below is a brief overview of anticipated risks, adapted from work by Lower Mainland Facilities Management and summarized in Figure 2.

Health services disruptions and supply chain disruptions: Facilities can expect increased strain as extreme events (e.g. flooding, wildfires, heat waves) lead to an increase in hospital visits by both vulnerable and general populations. Higher operational costs, including increased energy costs and necessary staff overtime, will reduce the ability of facilities to provide care.

Infrastructure damage and energy system impacts: Physical damage to facilities from storms and flooding can threaten building integrity and compromise sanitary conditions. Increases in air contaminants from wildfire activity, pollen and other sources can infiltrate through building envelopes, impacting the ability of HVAC systems to maintain adequate indoor environmental quality. Increasing temperatures and greater variability in conditions will place increased strain on equipment, leading to mechanical failure and unexpected equipment purchases.

Off-site infrastructure and resource demands: Hospitals and other health care facilities rely on the greater community to function effectively, and the changing climate threatens the continuity of many of these functions. Strain on municipal sewer infrastructure from increasing precipitation, for example, can lead to bacterial outbreaks that in turn place additional pressure on hospitals. Damage to utilities and roads as a result of extreme weather events can impede supply chains and the ability of people to reach the facility. In the future, shortages in regional power and water restrictions will further challenge facility operations.

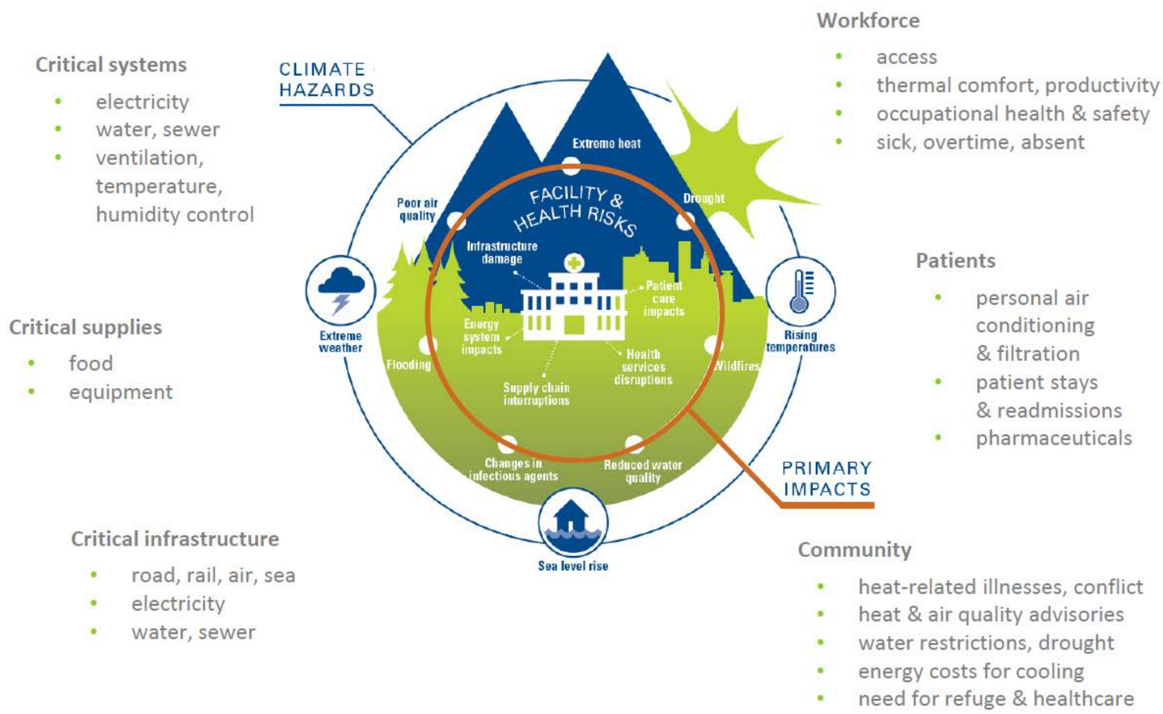

Figure 2: *Cascading impacts on buildings and infrastructure that can disrupt health services (modified from Source: Ministry of Health and the BC Climate Action Secretariat).*

3. PLANNING & DESIGN

Identifying hazards and potential risks early in planning and design ensures that appropriate responses can be incorporated at the building, site and off-site (i.e. community and health service delivery area) levels in a way that ensures greatest impact, and well before designs are finalized beyond the point of making reasonable or cost-effective adaptations.

This section provides an overview of how climate risks and resilience can be incorporated into the development of Site Plans and Facility Plans.

Site Plans include High Level Master Plans (HLMP), Clinical Plans and Infrastructure Plans. This section focuses on High Level Master Plans as key vehicles for contextualizing climate risks and resilience for a site in relation to its community of care over time. The intent is to provide a comprehensive, fulsome resource to inform multiple capital projects over time. It outlines resilient planning opportunities to better understand, reduce and manage climate hazard exposure, sensitivity and adaptive capacity at the site, community and service delivery scales.

Facility Plans include Concept Plans and Business Plans. Key concepts, information and framing are required at the project outset to establish a baseline and framework for climate resilience that enable consistency, improvement through iteration, and knowledge transfer as a project moves from concept to construction. This is especially the case as each phase may be overseen by a distinct project and consultant team, and involve key stakeholders including executive sponsors and project boards, procurement advisors, and the Ministry of Health.

Major capital projects can take up to ten years from inception to execution. As they are used as precursors to design for project scope and budget setting, Concept and Business Plans are the most impactful and cost-effective opportunities for reducing risks and building resilience over the lifespan of the project.

Concept and Business Plans are anchored in the clinical service plan and functional program. As project teams explore site locations and develop conceptual and/or indicative designs for the space, it is prudent to also identify natural hazard risks that may disrupt clinical services such that risk reduction and resilience measures can be costed to a reasonable degree of accuracy.

3.1. High Level Master Plan

High Level Master Plans are planning projects that include clinical and facilities studies (i.e. Clinical Service Plans and current facilities condition assessments, respectively) to inform Site and/or Facilities Master Plans and accommodate projected service growth over the short-, medium- and long-term. Site and/or Facilities Master Plans include high level budgets, phased schedules and climate resilience strategies. High Level Master Plans characterize the broader community of care with a review of key characteristics, indicators and trends, such as demographics and population growth.

Relevance to Climate Risks & Resilience

High Level Master Plans are key opportunities to contextualize climate risks for a site in terms of impacts on people, assets and infrastructure, and health services over time. They should outline climate hazard **exposure**, **sensitivity** and **adaptive capacity** at the census scale[3] (see Section 6.1 for definitions).

HLMP also should outline potential **resilient planning opportunities** (see below) at the scale of action (e.g. site and community). Descriptions of health service delivery areas include community-level sensitivity and adaptive

[3] Vancouver Coastal Health & Fraser Health (2020). *My Health My Community Survey.*

capacity to climate hazard exposure in the timeframe of the High Level Master Plan, including present day. Presenting projected community vulnerabilities alongside projected demographic and socio-economic trends can provide a valuable perspective to decision-making on health services and programs.

High Level Master Plans should anchor the project in the local climate planning context through references to key local government plans, progress and actions, including official community plans, climate adaptation plans and climate emergency declarations. The extent that critical infrastructure is planned, designed and operated with climate risk in mind has a bearing on all health services, whether provided at the site, in homes and in the community, or by the broader health system for all British Columbians (e.g. quaternary care). Similarly, a community's resilience to climate shocks and stresses has a bearing on the demand for health services at the site, service delivery area, and health system levels.

Responsibilities

Site planners are responsible for developing the High Level Master Plan. Capital project managers are responsible for providing updated data, information and analysis on climate hazards and risks for integration into the relevant High Level Master Plan.

Expected Results & Outputs

The High Level Master Plan should be a key resource for capital projects and planning on climate risks and resilience at the site, service delivery area, and health system levels.

Key Steps & Information

The primary steps in completing a High Level Master Plan include the following:

1) Review local government resources and community health vulnerability information for relevant information, including potential synergies or conflicts with meeting projected service growth. Examples include:
    - Conducting multi-hazard risk assessment rezoning condition to improve post-disaster functionality of critical infrastructure and services.
    - Achieving zero emissions by 2050 as outlined in the City of Vancouver's *Climate Emergency Action Plan*.
    - Enhancing the urban forest canopy and reduce the urban heat island effect to lessen the risk of extreme heat exposure, which is currently being prioritized by the City of Surrey[4] and others.
2) Carry out a Climate Hazard Exposure Screen (as described in Section 6.1) with key stakeholders in local government and the community of care. Where possible, carry out resilient planning (see below) to better understand the sensitivity and adaptive capacity of communities, assets and infrastructure. Exchange information with key health systems stakeholders to support completion of a Health Vulnerability Assessment[5].
3) Develop plans and actions to advance collaboration in reducing exposure and sensitivity to climate hazards, and enhance capacity to adapt (described in detail in Section 6.1).
4) Incorporate results into the relevant High Level Master Plan to ensure project access to the most updated information.

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[4] City of Surrey. (2020). *Urban Heat Ready.*

[5] See the Health Canada *Health Vulnerability Adaptation Assessment Workbook* (2020) for guidance on assessing and planning for adaptation using a community health lens.

Resilient Planning Opportunities

High Level Master Plans characterize a dynamic community of care that is served by a network of critical infrastructure including health facilities, roads and utilities (e.g. water, sewerage, power). Key information about the exposure, sensitivity and adaptive capacity of people, assets and infrastructure should be included in a review of a community's key characteristics, indicators and trends. The tools and processes described below may be used to:

- **a)** Map exposure, sensitivity and adaptive capacity (for service delivery areas);
- **b)** Quantify the costs of action (for sites and infrastructure portfolios); and
- **c)** Achieve co-benefits for health and climate resilience (for sites and communities).

A: Mapping climate hazard exposure, sensitivity and adaptive capacity at the community level

Site planners can use information on community vulnerability to inform service demand projections in High Level Master Plans and Concept Plans. For example, heat, wildfire smoke and flood vulnerability maps, such as those developed through the HealthADAPT project[6] (Figure 3) can be used to:

- Pinpoint physiological and social determinants of health that play key roles in climate vulnerability
- Identify neighbourhoods or communities that may need more resources or support to cope
- Mobilize multi-sectoral efforts to improve community health outcomes

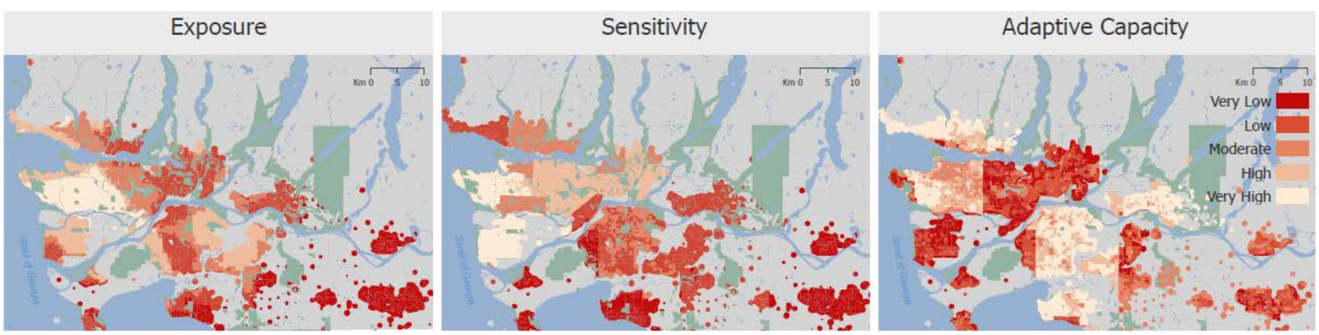

Figure 3: *Community exposure, sensitivity and adaptive capacity to days above 25°C in recent past (Source: HealthADAPT, 2020).*

In this example, when considering the risk of extreme heat events, exposure is linked to projected temperature changes and sensitivity is determined by two key factors that affect individual health: the age of the population and their pre-existing health conditions (e.g. older people are more prone to heat-related illnesses such as heat stroke and heat exhaustion). Adaptive capacity, the ability to respond to extreme heat events, is determined by

[6] The maps were developed as part of the Fraser Health and Vancouver Coastal Health *HealthADAPT Project* funded by Health Canada's Climate Change and Health Adaptation Capacity Building Contribution Funding Program. The maps were developed on the basis of a preliminary study by UBC's School of Population and Public Health. For more information, see *Mapping Spatial* **Patterns in *Vulnerability* to Climate Change-Related Health Hazards: 2020 Report** (Yu, Jessica; Castellani, Kaitlin; Yao, Angela; Cawley, Krista; Zhao, Xuan; Brauer, Michael; 2020).

factors such as income, housing, education and literacy. The maps in Figure 3 were created by GIS specialists, interpreted by public health experts, and developed into [Story Maps] to support local stakeholder engagement.

Such maps can further support collaboration among health system operators (e.g. facilities management, public health, emergency management, disease monitoring and surveillance), local governments, social housing and others to ensure that public services, such as clean air shelters and cooling centres, are located in areas of highest need.

B: Quantifying costs of action at the site and infrastructure portfolio levels

Site planners can also use interactive tools to better understand the value of investing in resilience today, as opposed to at the end of critical asset and infrastructure service lives. For example, the BC Climate Action Secretariat, Health Authorities and others piloted in 2019/20 the XDI Globe Cross Dependency Initiative, an online platform for assessing climate hazard risk for off-site assets and infrastructure that are critical to health facility functionality, and costing adaptation pathways for on-site health facility assets and infrastructure (Figure 4).

Figure 4: *Interactive analysis of climate risk for critical infrastructure in BC (Source: XDI Globe).*

C: Achieving co-benefits for health and climate resilience at the site and community levels

Site plans can also include information on the use of green infrastructure, green space and urban forest canopy to achieve co-benefits for patients, health workers, and community over a facility's lifespan.

Table 3 provides examples of evidence-based design strategies to integrate health and climate resilience co-benefits of urban greening at the site and community levels. See the Resilience Guidelines' companion document *Green Design for Climate Resilience & Well-Being* for illustrations and descriptions of an experiential pathway of green designs from inside a health facility to green space in the surrounding neighbourhoods.

Table 3: Urban greening strategies for health and climate co-benefits (Source: UBC Collaborative for Advanced Landscape Planning, 2020)

Green Design Strategy	Anticipated Health & Climate Co-benefits
View from Within	• Visual biophilic experiences • Wildlife habitat and biodiversity
Plant Entrances	• Social gathering space • Orientation/navigation • Shade provisioning/cooling • Building energy savings
Bring Nature Nearby	• Social gathering space • Wildlife habitat provision and biodiversity • Stormwater mitigation
Retain the Mature	• Air filtration • Building energy savings • Carbon storage and sequestration • Shade provisioning/cooling
Generate Diversity	• Visual biophilic experiences • Wildlife habitat provision and biodiversity
Create Refuge	• Social gathering space for cohesion and enhanced social capital • Shade provisioning/cooling • Air filtration • Wildlife habitat and biodiversity
Connect Experiences	• Visual biophilic experiences • Shade provisioning/cooling • Wildlife habitat provision and biodiversity (e.g. ecological corridors) • Stormwater mitigation
Optimize Infrastructure	• Urban heat island mitigation • Carbon storage and sequestration • Stormwater mitigation • Wildlife habitat provision and biodiversity

3.3. Concept Plan

A Concept Plan describes the need for investment and provides **a site options analysis**. Key service delivery area information such as population growth and demographics (e.g. culture, ethnicity, socio-economic status, age) contextualise the need for future care service. Ministry of Health policy directives (e.g. *Primary and Community Care Strategy*), Health Authority goals and objectives, and Provincial requirements for reducing climate risks and greenhouse gas emissions are embedded to ensure strategic alignment and compliance (e.g. annual reports on plans, actions and progress in reducing climate risks). Cost estimates and funding requirements (e.g. capital, ongoing operating, one-time/start-up costs) are outlined. System reliability, future capacity and redundancy are incorporated into the concept design and the budget as per post-disaster requirements in the *BC Building Code*.

Relevance to Climate Risks & Resilience

Concept Plans should include a situational overview to support identification of potential issues for further consideration (e.g. land reclamation, liquefaction hazard). Key information for conceptual design includes site-specific climate projections data, analyses and recommendations for further study (see ***Box 1***). Information gaps must be identified with a literature review and a preliminary climate hazard exposure screen.

Box 1: *Calculating Future Changes in Temperature*

Future climate projections data for sites and health service delivery areas, such as in the table below, can be obtained from the Pacific Climate Impacts Consortium. To calculate the future values for a climate indicator, add a site's past value to the future change value of interest (i.e. lower bound, average, or higher bound). The average value may be used for simplicity. (Source: Moving Towards Climate Resilient Health Facilities for Fraser Health – Technical Briefing, 2019)

*The **past** Hot Design 97.5 climate indicator value is **28.6°C***

*The average future change value for year **2050** is **3.9°C***

CLIMATE INDICATOR	PAST	2020 CHANGE (range)	2050 CHANGE (range)	2080 CHANGE (range)
Days Above 25°C	33	18 (12 to 24)	40 (22 to 56)	67 (39 to 96)
Days Above 30°C	6	7 (4 to 9)	19 (11 to 27)	38 (22 to 61)
Hot Design 97.5 (°C)	28.6°C	1.9°C (1.3 to 2.4)	3.9°C (2.7 to 5.4)	6.3°C (4.2 to 8.8)
Hottest Day (°C)	32.3°C	1.9°C (1.0 to 2.6)	4.0°C (2.7 to 5.0)	6.5°C (4.5 to 8.4)

*Therefore, the **future 2050 change** value for the Hot Design 97.5 is **28.6°C + 3.9°C = 32.5°C**. The lower and higher-bound values are 28.6°C + 2.7°C = 31.3°C and 28.6°C + 5.4°C = 34.0°C, respectively.*

Responsibilities

The **Health Authority** is responsible for preparing the Concept Plan, and carrying out the Climate Hazard Exposure Assessment. The project team is responsible for securing the capacity and resources required to understand climate risks and develop a conceptual design that reduces risks that are discernible. Health

Authorities' internal capacity in climate resilience, energy and emissions, and environmental sustainability are core actors.

Consultants are responsible for carrying out technical studies and preparing reports, including environmental reviews, site assessments and geotechnical analyses.

Subject matter experts, such as climate scientists and modellers, are responsible for providing information and expertise to support interpretation of future climate data for single and compounding hazard risks, as well as information about other sectors' approaches (e.g. transportation, agriculture).

Expected Results & Outputs

The Health Authority will conduct high level due diligence in alignment with its mandate to reduce human health vulnerability to climate change, and to align operations with targets and strategies for minimizing greenhouse gas emissions and managing climate change risk. Site options and cost estimates in the Concept Plan should account for material climate hazards from opening day to facility end-life. Upon receiving approval to proceed, the Health Authority must ensure that the detailed data, information and analysis required to establish a baseline for design are completed prior to Business Plan initiation.

Specifically, the Concept Plan should include the Health Authority mandate to reduce human health vulnerability to climate change, and climate hazard exposure of the project. The Conceptual Design, project site analysis and other key project elements should include data, information and analysis on likely climate impacts that are material to the project. Technical reports (e.g. mechanical, electrical, structural and geo-technical) should demonstrably incorporate Climate Hazard Exposure Screen outputs.

In a practical example, if the exposure screen indicates that one or more site options are located in a flood-prone area, then the Concept Plan should explore key considerations for reducing flood hazard exposure from opening day to facility end-life. Supplementary modelling and analyses may involve a high level analysis of how changes in hazard exposure over time are impacted by:

- Precipitation;
- Drought (e.g. impact on on-site absorption of heavy rainfall);
- Freeze/thaw (e.g. impact on the viability of potential design strategies such as permeable pavement);
- Erosion;
- Subsidence due to depleted water table; or
- Saltwater intrusion due to sea level rise.

The Concept Plan should also consider potential impacts by or on adjacent areas, such as flooding of a major access road with risk that increases over time.

Key Steps & Information

The key steps in developing the Concept Plan include the following:

1) Identify key information in the High Level Master Plan, such as:
    - Region and site-specific climate projections data, analyses and recommendations for further study
    - Community exposure, sensitivity and adaptive capacity
2) Carry out a Climate Hazard Exposure Screening (see Section 6.1) informed by a literature review and expert consultation.
3) Address data and information gaps, such as projected wind loads, with technical study and analysis.

4) Incorporate key information and recommendations into Concept Plan.

5) Develop recommendations for next steps, including:

    - Summarize climate risks to facility and health system
    - Summarize community vulnerability
    - Carry out future climate change planning; Review resilience opportunities with Project Team and/or Environmental Sustainability; No action needed

3.4. Business Plan

A Business Plan is "the final activity of the planning phase undertaken to establish an accurate degree of scope, cost and schedule certainty for the recommended option identified in the concept plan" and it "captures the reasoning for initiating a project, generates support and participation needed to turn an idea into reality and provides evidence that the project is a good investment"[7]. A Business Plan aligns clinical programming with a facility's asset and infrastructure needs (e.g. space, utility connections) to meet the anticipated clinical and facility operations demands.

Business Plan key Project elements include:

- Indicative design details
- Municipal approvals
- Project site considerations
- Detailed assessments of non-financial factors (e.g. environmental, job creation, public health or other socio-economic impacts) and associated public interest issues (e.g. access, security and safety)
- A risk report (i.e. related to project scope, cost and schedule)

Relevance to Climate Risk & Resilience

In the context of our climate reality, reducing climate risks to clinical and facility operations through climate-smart planning and design is a necessary part of demonstrating that a project is a good investment. Equally important is to reduce future climate risks by working towards net zero emissions by 2050. As such, a **design options analysis** should be informed by a climate risk assessment that identifies key vulnerabilities and risks to inform functional requirements, layouts and systems for each design option, and by a feasibility study on achieving net zero emissions by 2050, to "align operations with targets and strategies for minimizing greenhouse gas emissions and managing climate change risk"[8].

At minimum, two design options should be prepared on the basis of assessment results and recommendations: Base and Enhanced Design. Whilst both design options are low carbon (i.e. designed to achieve net zero emissions by 2050), the Base Design serves to establish a low carbon resilience baseline for developing requirements and compliance measures (e.g. design to facility half-life, with flexibility to end-life), whereas the Enhanced Design aims to achieve "stretch" targets beyond the requirements (e.g. Net Zero Emissions by 2050 on-site and off-site) and to incent innovation (e.g. with resiliency scored elements) with an incremental construction cost increase as prescribed in the project approval letter.

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[7] Ministry of Health. (2020). *Health Capital Policy Manual, Glossary*.

[8] 2020/2021 Board Mandate Letters

As the Business Plan also includes related public sector leadership commitments such as Low Carbon Cement, Wood First and LEED Gold certification, the design options analysis should optimize synergies with sustainability and energy goals as well.

Responsibilities

The **Health Authority** and **Indicative Design Team** are responsible for preparing the Business Plan.

The **Indicative Design Team** is responsible for carrying out the Preliminary Climate Risk Assessment in a workshop or design charrette. The Health Authority will carry out pre-workshop activities.

Expected Results & Outputs

The Business Plan should include:

- ✓ Base and Enhanced Design Options and cost estimates that reflect the best available information on climate resilience measures to inform decision-making;
- ✓ Synergistic and innovative low carbon resilience strategies;
- ✓ The most important design elements to translate into design and construction specifications; and
- ✓ Manageable residual risks to facility and clinical operations.

Next steps should ensure that output specifications include proposal requirements, compliance measures and evaluation criteria, incentives (e.g. scored elements), and elimination options (e.g. scope ladders and priced adjustments).

Key Steps & Information

Health Authority

1) Begin preparing for the Preliminary Climate Risk Assessment Workshop (detailed in Section 6.2) upon Concept Plan approval, participate in the workshop, and approve the workshop report.
2) Provide key information to the Indicative Design Team prior to the workshop, and approve the post-workshop summary of resilient design objectives, strategies and implementation pathways provided by the Indicative Design Team.
3) Ensure that costing of resilient design strategies for the Base and Enhanced Design Options is included in the cost consultant or quantity surveyor's scope of work:
    - With reference to industry innovations and best practices;
    - Describing cost in both monetary and non-monetary (e.g. occupant health, social cohesion) terms; and
    - Informed by a lifecycle cost analysis.
4) Include a resilience budget line and contingency for the Base and Enhanced Design Option.
5) Allocate 4-6% of the total budget to Resiliency Scored Elements.
6) Work to integrate key risk information and resilience strategies into the facility Risk Register in collaboration with asset managers, and into the High Level Master Plan, Infrastructure and Clinical Plans with capital planners.

Indicative Design Team Prime Consultant

1) Review key information with the Design Team to understand the context, including:
    - Climate Hazard Exposure Screen outputs and recommendations;
    - Supplementary technical study outputs (e.g. flood risk analysis); and
    - municipal plans, policies, regulatory obligations (e.g. on-site rainfall capture) and bylaws that are relevant to the climate hazards identified (e.g. hazard development permit areas).
2) Direct the team to identify and address key information needs and gaps, for example by:
    - Consulting additional hazard resources, and subject matter experts;
    - Conducting high-level technical study, scenario analysis or modelling (e.g. wind load study); and
    - Initiating a feasibility study on reaching net zero emissions by 2050.
3) Facilitate Design Team input into the Preliminary Climate Risk Assessment Workshop (see Section 6.2) by:
    - Preparing an inventory of design strategies that may inherently increase resilience (e.g. existing Health Authority or municipal requirements);
    - Reviewing resilient design strategies in Section 8 of the Resilience Guidelines; and
    - Canvassing industry peers and organizations for other best practices, and cost estimates (in order of magnitude).
4) Carry out a Preliminary Climate Risk Assessment Workshop (see Section 6.2).
5) Review the workshop report results (i.e. facilitator report), in particular the impact statements ranked as major (4) and catastrophic (5), and proposed resilient design strategies. Develop a prioritisation process

with criteria including GHG emissions reductions potential, and synergy with seismic and pandemic risk reduction.

6) Incorporate resilient design strategies and implementation pathways into design briefs (e.g. mechanical, structural, LEED) that inform Indicative Design development and Design Options costing carried out by the Health Authority's cost consultant. Design briefs will:
   - Clearly indicate resilient design strategies and pathways to facility half life and end life;
   - Flag key interdependencies (e.g. a higher performance building envelope reduces chiller plant size) and success factors (e.g. connections for future renewable energy production, storage and transmission); and
   - Will be informed by energy modelling (i.e. using future shifted weather files), and by energy and carbon targets for the project.
7) Submit an overview summary of resilient design objectives, strategies and implementation pathways to the Health Authority that:
   - Is a counterpart to the Workshop report;
   - Provides an analysis of cost estimates;
   - Describes the strategy prioritisation process; and
   - Can be used by the Health Authority in climate action reporting.

3.5. Design

Resilient Design Objectives should be integrated into Site Plans, Facility Plans and Project Agreements for optimal cascading benefits from initiation of concept to end of construction. Where possible, they are formulated in relation to Project Objectives with the intent to convey the materiality of climate risks to health service delivery. Resilient Design Objectives serve as North Stars for resilience-based requirements, compliance measures and design strategies.

Responsibilities

Health Authorities are responsible for ensuring that capital projects meet Resilient Design Objectives by developing project **requirements** informed by climate risk assessments and collaborating with Proponents (including Successful Proponents) to ensure **compliance**.

Expected Results & Outputs

See **Section 5 on Procurement for requirements and compliance measures**, and **Section 8 for resilient design strategies** that are aligned with the Resilient Design Objectives below.

Resilient Design Objectives

Resilient Design Objectives are organized by those that increase facility resilience in a broad sense, and those that address either acute shocks (i.e. extreme heat, air quality impacts, flooding, and power outage) and chronic stresses (e.g. water shortage and drought, moisture and humidity, freeze/thaw, snowfall and wind).

General Resilience

- ✓ Develop a climate lens for all capital expenditures that incorporates lifecycle costs of facilities under future climate conditions. Offset resilience investments with projected operational costs savings over facility lifespans.
- ✓ Create an inventory of essential supplies (noting shelf life), and verify supply chain resilience during climate stress events.

- ✓ Develop Standard Operating Procedures, and offer frontline staff training on operating facilities and providing health services under climate stress conditions.
- ✓ Work with utilities and local governments to understand regional priorities for critical service provision during new extreme events, such as firefighting, water supply, electrical supply, transportation, and site access.
- ✓ Strengthen partnerships with local and regional governments to improve community resilience by strengthening community health.

Extreme Heat

Prolonged periods of abnormally hot weather, often paired with high humidity, are projected to increase in frequency and intensity as a result of climate change. These conditions place occupants at risk of heat exhaustion, overheating, dehydration, and hyperthermia. Maintaining indoor thermal comfort for patients and staff will become increasingly difficult if the facility has not been designed for future climate conditions. Longer periods of hot temperatures and increased temperature variability may also result in higher operational costs (e.g. energy costs and staff overtime), increased wear on mechanical equipment, and unexpected equipment purchases to supplement heating and cooling needs.

To ensure that health facilities are designed to meet the demands of a warming climate, Design Teams must implement measures that meet the following Resilient Design Objectives:

- ✓ Ensure thermal comfort and safety of occupants and patients into the future.
- ✓ Design more responsive, flexible heating and cooling solutions to help buildings adapt to daily and weekly temperature fluctuations based on climate projections.
- ✓ Ensure facility operations can withstand and respond quickly to extreme heat/disruptions with minimal impact on clinical operations.
- ✓ Prioritize passive design to reduce energy and emissions and improve passive survivability.
- ✓ Reduce local urban heat island effect.
- ✓ Increase external shade and use of trees to provide shade.

Air Quality Impacts

As the climate warms, health facilities will face increases in air-borne contaminants from wildfire activity, atmospheric ozone, pollen and other sources, which can infiltrate through building envelopes and impact the ability of mechanical systems to maintain adequate indoor environmental quality. These contaminants can have serious negative health impacts on occupants, including headaches, asthma, and respiratory irritation. At health facilities, poor indoor environmental quality can also promote bacterial growth and the transmission of infectious diseases.

To limit the impact of wildfire smoke and other air-borne contaminants, and improve indoor environmental quality, Design Teams must implement measures that meet the following objectives:

- ✓ Ensure indoor environmental quality for occupants into the future.
- ✓ Design high-quality air filtration systems to cope with changing external conditions.
- ✓ Ensure the facility can maintain adequate indoor air quality across different air quality hazard scenarios (e.g. wildfire smoke, pandemic).
- ✓ Regularly assess and communicate indoor and outdoor air quality.

Flooding

Flooding can be caused by extreme rainfall events that overwhelm local stormwater drainage capacity, and as a result of sea level rise, river overflow, snow melt, system backup, and plumbing failures. These shocks and stresses are anticipated to increase in frequency and severity over time due to climate change, and can lead to building damage, weakened foundations and structural integrity, utility service interruption (including power and sewage systems), and loss of property and equipment. At health facilities, flooding can also result in unsanitary operating conditions, along with negative physical and mental health impacts for facility staff and patients.

To limit the occurrence of flooding at health facilities, and minimize damage and disruption should flooding occur, Design Teams must implement measures that meet the following primary project objectives:

- ✓ Manage risk of flooding at both the facility and on the site, with consideration of the community members that a facility may need to serve even if the facility itself is not at risk.
- ✓ Ensure the safety of facility occupants while limiting damage to key facility systems and services.
- ✓ Limit widespread contamination of facility services and operations from floodwaters.
- ✓ Limit any added stress on municipal stormwater infrastructure and nearby waterways from floodwater, sediment and contaminants.
- ✓ Facilitate efficient and cost-effective restoration following a flood event in design and material choice.

Power Outage

Building power systems are subject to a number of climate-related threats – high demand for cooling during heat waves may overwhelm the grid, and flooding may down power lines or flood critical infrastructure – and these challenges will only increase in the future. As health facilities must have reliable power supplies to maintain appropriate interior temperatures and ventilation rates, any interruption to these systems can have dramatic consequences on patient care.

To enhance the resilience of power supplies at health facilities, and prepare the facilities to meet future electrical demands, Design Teams must implement measures that meet the following primary project objectives:

- ✓ Minimize disruption and ensure continued operations of the facility during a power outage.
- ✓ Ensure the safety of facility occupants during a power outage.
- ✓ Limit damage to key facility systems and services .
- ✓ Reduce reliance on utility providers through renewable energy generation and battery storage.

Chronic Stressors

In addition to shock events, health facilities in BC face a range chronic stressors that are more gradual in nature but can still cause major damage over time. For example, in BC's northern latitudes, warmer winters may lead to more frequent freeze/thaw cycles, which can in turn result in higher rates of weather of building materials and general moisture damage. While not a comprehensive list of all possible chronic stressors, Design Teams must implement measures to achieve the following objectives at a minimum:

- ✓ Design for maximum water efficiency and water reuse to minimize disruption and ensure continued operations during water shortage and/or drought.
- ✓ Limit damage to building materials from moisture and/or humidity ingress.
- ✓ Minimize damage from freeze/thaw cycles.
- ✓ Ensure the facility is equipped to manage snowfall quickly and safely, both current and projected.
- ✓ Limit damage to the facility and potential risks to users that may result from high winds and storms.

Design Stages

The applicable Resilient Design Objectives for a project will depend on the outcomes of the Climate Risk Assessment, which has four main steps that each take place at different stages of design. This process is summarized in Table 4 below and presented in detail in Section 6.

The Resilience Guidelines are most readily applicable to Design Build and P3 projects. However, with modification and early application in the planning and design process, core elements may be customised for projects utilising Alliance, Construction Management and Design-Bid-Build procurement models.

Table 4: *Climate Risk Assessment process linked to design stages.*

Design Stage	Climate Risk Assessment Step
Conceptual Design • Early phase of design • Architect produces a concept sketch based on general description of location, gross floor areas based on the Functional Program, and key adjacencies • Construction cost accuracy: +25% to -25%	**Step 1: Climate Hazard Exposure Screen** **Informs** the development of a site in the context of a dynamic community of care and accelerating climate change (High Level Master Plan), and the selection of site options (Concept Plan). The **intent** is to provide context on climate hazards over time to understand potential impacts on the site, health service delivery area and broader health system over the medium to long-term. **Results** provide information for other health and public sector projects, and interdependency analyses.
Indicative Design • Identifies the functional requirements and the arrangement of spaces at a proposed site/facility • Establishes building layouts • Confirms assumptions informing the functional program • Establishes building systems	**Step 2: Preliminary Climate Risk Assessment** **Informs** the development of Base and Enhanced Design Options for the Business Plan. After Business Plan approval, it informs the development of design and construction specifications for the market. The **intent** is to provide a nuanced and fulsome understanding of climate risks to people, assets and infrastructure, health services. **Results** include validated resilient design objectives that are included in the Business Plan, resilient design strategies and implementation pathways that are incorporated into the Base and Enhanced Design Options, Class C capital cost estimates that reflect lifecycle costs, and an Indicative Design that sets a resilience baseline for Designers and Builders in subsequent steps.
Schematic Design • Translates the Functional Program into preliminary drawings • Defines the design intent, site location, general floor layout and description of building system infrastructure • Construction cost accuracy: +15% to -15%	**Step 3: Climate Risk Assessment Workshop** **Informs** the development of Technical Submissions by Proponents. The **intent** is to enable a clear understanding of the Design & Construction specifications, including how to comply with requirements and achieve scored elements. The **result** is that Proponents provide Technical Submissions that are compliant.

Design Stage	Climate Risk Assessment Step
Detailed Design • Plans, sections, and elevations are drawn to scale, principal dimensions are noted, the structural system is laid out, and major mechanical and electrical components and distribution routes are located • Critical interior spaces are drawn and elevated for review • Construction cost accuracy: +10% to -10%	**Step 4: Climate Resilience Compliance Audit** **Informs** how the Successful Proponent's design sufficiently addresses climate risks and project requirements, and confirm any equal-or-better alternatives. The **intent** is to establish a collaborative and iterative mechanism for the Successful Proponent, Health Authority, and Compliance Team (or Independent Climate Risk Auditor) to review the evidence base provided by the Successful Proponent and ensure that resilient design objectives are met. The **result** is sufficient information to determine compliance, rewards or penalties.

4. PROJECT PROCUREMENT

Health capital project teams rely on the skills, knowledge, experience and networks of the professional services community to plan and design health facilities that are climate-resilient to the end of service life. To help set expectations, ensure an evidence-based and iterative approach, and create a level playing field in a competitive context, this section provides sample text for project and consultant procurement for:

- Requests for proposals for Design Teams and compliance teams;
- Proposal requirements and evaluation criteria for technical and financial submissions;
- Consultants contracts, including:
- Vendors (amendments for existing and content for new)
- Subject matter experts and key project supports

This section is developed for Design Build and P3 Projects. With modifications and early application, it also may apply to Alliance, Construction Management and Design Bid Build Projects.

4.1. Business Plan

Indicative Design Team & Compliance Team RFP

Section	Proposed Content
Project Information	**Reference Documents sub-section:** Reference documents available to interested proponents include: • Climate Projections data and reports by Health Authority, local and regional government, scientific and academic institutions, and / or other publicly-available and credible resources • Climate hazard exposure screen summary overview by Health Authority
Scope of Services	**Services sub-section:** The consulting team, led by a Prime Consultant, will include sub-consultants with the following competencies: • Leading Climate Risk Assessments • Energy and Energy Modelling using future shifted weather files • LEED/Sustainability with experience using RELi or resiliency credits The Prime Consultant will to the satisfaction of the Authority's Project team: • Synthesize and incorporate the findings, manage and coordinate all consultants' work, details, and specifications related to this Project. • Review climate hazard risk-related information in previous planning work as well as reference Health Authority and local government design guidelines and strategies. This includes the: o High Level Master Plan o Concept Plan

- Site condition reports including survey, geotechnical, environmental, hazardous materials.

- Review previous work related to climate risks including:
    - Future climate Projections data and reports
    - Climate Hazard Exposure Screen results and recommendations
    - Resilience Guidelines for Health Facility Planning & Design (2020)
    - Establishing Design Conditions for Health Facility Planning and Design (2020)
    - Climate adaptation strategies and action plans as per local and regional governments
    - Nature-based solutions, urban forest and green infrastructure strategies
    - Identify climate risk information gaps in above-mentioned work (e.g. compounding hazard risks material to the project), and propose a methodology and approach to addressing gaps

- Develop an overall Climate Resilience Strategy that:
    - Clearly identifies resilience objectives and design strategies (i.e. options and implementation pathways) to facility half-life and end-life
    - Establishes resilience targets for priority hazard risks
    - Clearly indicates synergies and trade-offs among resilient design options in relation to implementation pathways, and emissions reductions pathways
    - Is informed by QS cost estimates for critical assets and infrastructure (e.g. mechanical, electrical, structural)
    - Fosters synergy and innovation in reducing natural hazard risks through design by integrating infectious disease and seismic risks into the climate risk assessment with a view to ensuring overall public and occupant health
    - Involves consultation with clinical stakeholders and Authority subject matter experts to review the Indicative Design as it progresses, understand clinical operational risks associated with infectious disease, seismic and climate risks, and adjust until design achieves final sign-off from stakeholders and subject matter experts.

- Develop an overall Energy and Emissions Reduction Strategy that:
    - Uses energy modelling and simulation exercises as per Establishing Design Conditions for Health Facility Planning and Design (2020)
    - Is informed by a high-level Net Zero Emissions and Net Zero Ready by 2050 feasibility assessment
    - Establishes emissions reduction and energy conservation / efficiency targets, as directed by the Health Authority

- Prepare a LEED Gold strategy including a preliminary list of mandatory and strongly preferred credits with a view to enhancing occupant health and well-being, in consultation with the Health Authority

- Develop at minimum two design options whereby low carbon climate resilience is the baseline:

1) Base: A climate resilient and low carbon hospital that is:

- Technology and virtual care enabled;

	- Resilient to future pandemic and seismic risks from opening day to half-life (i.e. 30 years), and opening day to end-life (i.e. 60 years); and, - Flexible and prepared to closing day (i.e. end of service life, extended service life). - With a clear understanding of natural hazard risks and resilience, the building and campus design also applies a sustainability lens from the outset with consideration of design strategies such as building orientation, envelope design, and other no/low-cost strategies. Co-benefits such as emissions reduction, seismic and pandemic risk reduction, occupant health, benefits for staff, environmental rejuvenation or regeneration, and reduced thermal plant size due to passive and reduction measures are emphasized. The hospital will meet a zero-emissions by 2050 outcome for operating energy (i.e. no on-site and no marginal electricity emissions) and will be required to meet or exceed LEED Gold. **2) Enhanced:** Additional resilience and sustainable design features to facility end-life also examines negative carbon emissions (i.e. sequestered carbon and grid reductions for other customers). The capital cost and life cycle benefits of enhanced features are to be described and quantified by the Proponent for decision makers.

Proposal Contents	**<u>Approach & Methodology</u>**
	- Describe your methodology including but limited to integrated design for a resilient, sustainable and healthy facility.
	- Describe the Project team and its approach to aligning and developing design strategies for buildings that thrive due to their ability to benefit from synergistic solutions and function as a holistic system while minimizing risk and cost. Specifically, describe your approach to avoid unintended consequences of a siloed approach or how a collaborative or integrative approach will be used
	<u>Company Profile: Qualifications, Experience & Resources</u>
	- Relevant skills and capacity:
	  - Climate projections data interpretation, analysis and incorporation into options analysis
	  - Evaluating synergies, conflicts and trade-offs between reducing climate risks and GHG emissions
	  - Infectious disease control, seismic and climate risk assessment and design
	- Required competencies:
	  - Familiarity with industry innovations within the last two years (e.g. CSA, ASHRAE, ISO, USGBC)
	- Expertise in:
	  - Grid-connected regulations, interactive controls, and service contracts
	  - Marginal GHG accounting
	  - Thermal and electrical energy storage
	  - Site renewable energy, both thermal and electrical including solar, wind, and biomass
	  - Energy demand, storage, and supply modelling
	  - Embodied energy and carbon sequestration analysis and selection

	o Total energy cost accounting combining energy efficiency, demand management, site energy, and off-site power contracts • Preferred competencies in: o Life cycle assessment and total cost of ownership o Demonstrated experience of the identified key project personnel o Carrying out climate risk assessments, and developing design options and solutions (using assessment results) that inform design of systems (e.g. mechanical), buildings and sites o Integrating emissions reduction and adaptation strategies using a multi-scale approach o Optimizing design solutions over the whole life-time of the facility o Minimizing the adverse impacts of the built environment on natural resources and surrounding ecosystems, while enhancing human health and well-being o Energy modeling and analysis using future shifted weather files as per Establishing Design Conditions for Health Facility Planning and Design o Designing and simulating buildings (ideally in healthcare) that include most or all of the strategies listed in Section 8 of this document

Resilience Matrix

In the Business Plan phase, develop a Resilience Matrix[9] to help meet resilience objectives and ensure the highest level of resilience is achieved within the capital cost ceiling.

The intent of the process[10] below is to help the Authority to establish a baseline for resilience, determine the cost to achieve incremental improvements towards the highest resilience levels, and incorporate a level of resilience to priority hazards into the indicative design.

Setting the Baseline

1) The technical team needs to understand the Scored Element Categories and Objectives, prioritize each one based on the project's objectives and the site conditions, and then incorporate some level of resilience requirements into the Indicative Design (e.g. Seismic Performance Level S3, Extreme Heat Wave Level H2, etc.).
    - This step is very project specific and depends greatly on the Owner, functional program, and existing site conditions.
    - Hazards may include discrete events (e.g. extreme heat wave, power outage, seismic) and ongoing stresses (e.g. warmer drier summers).
2) The compliance team and the quantity surveyor then need to determine the cost to achieve the higher/highest level for each category of the Resilience Guidelines matrix. For example, what would be the cost to go from level S3 to level S5 in the seismic performance climate resilience?
    - The compliance team determines which categories can feasibly be improved from the baseline.
    - Based on the cost estimate, the Owner may select the categories that can be improved with a reasonable incremental cost.

[9] Proposed by BC Housing's Mobilizing Building Adaptation and Resilience (MBAR) Project
[10] Developed by Partnerships BC

Scored Elements

- After completing Steps 1 and 2 of the Resilience Matrix, the Health Authority then decides on the total value of the Climate Resilience Scored Elements, and the distribution of the points among the categories (the weighting).
- A starting point for the point distribution can be based on the cost to achieve the maximum in each category.
- The total value of the scored elements or even the points distribution does not need to co-relate with the total cost to achieve the maximum in each category.
- Ultimately the points distribution should reflect the Owner’s or the Province’s priorities.
- Total value of the scored elements should be based on a value the Owner is willing to pay and the level of risk the Health Authority is looking to reduce beyond the baseline/indicative design.

Reverse Scope Ladder

- After completing Steps 1 and 2 of the Resilience Matrix, the Owner will need to rank the categories and identify the preferred option, which then the bidders would price in sequence.
- This allows the Owner to achieve the desired level of resilience while still being under the capital cost ceiling for the project.
- During the Preferred Proponent stage these items will be incorporated into the final contract and the final contract price.
- If the Proponents have cost pressures to stay below the capital cost ceiling, they will not price the reverse scope ladder.

Priced Adjustments

- After completing Steps 1 and 2 of the Resilience Matrix, all categories and options are presented to the Proponents with a proposed NPV adjustment for each.
- This offers the Proponents a bidding menu and is similar to a pre-priced change order.
- The Owner provides the additional specifications/scope of work to achieve the desired level or resilience in each categories, and the price (NPV adjustment) the Owner is willing to pay to achieve this level of resilience.
- Bidders can perform a cost benefit analysis and weigh their cost to achieve the greater level of resilience vs the Owner’s offered NPV adjustment.
- Bidders accepting the additional scope of work receive the benefit (NPV adjustment) those that do not, receive no adjustment.
- There is no technical evaluation/assessment of how well the proposed design meets the resilience matrix categories. The selected level of resilience becomes a prescriptive spec.

4.2. Request for Proposal

Key Project Elements

In respect to climate change, there are three primary RFP categories to consider:

1) Climate Risks and Resilience
2) Energy and Emissions
3) Sustainability (e.g. LEED certification)

Affordability

Project output specifications (including Owner's Project Requirements or OPR) are provided to bidders during the RFP phase for schematic design. Supplementary information may include workshop reports.

To encourage innovation beyond the Requirements and under the capital cost ceiling, scored elements may be developed with the support of procurement advisors and subject matter experts.

Proposal Requirements for Technical Submission

- Provide a list of data and information sources relating to priority climate hazards, future projections data, and climate risk and resilience assessment methodology that will be utilized to develop the Proponent's design for the project.
- Provide a report describing climate risks to the project, and proposed design solutions to reduce climate risks.
- Provide a narrative describing the Proponent's approach and methodology to develop and carry out a Project Climate Risk and Resilience Assessment Workshop; in particular, identify and prioritize resilient design strategies and adaptation pathways to facility end-life, and utilize these results to inform the Proponent's design for the project, as per Section 3.11 of the RFP.

Resiliency Scored Element

Scored elements are intended to incentivise Proponents to go behind requirements. Below is an example of a Resiliency Scored Element that aims to better ensure minimal disruptions to service delivery in the event of a prolonged extreme heat event. It is important to note that the intent is to support achievement of clinical service objectives.

Evaluation Criteria for Extreme Heat Events

The goal is to incent the incorporation of provisions to maintain the health, well-being and productivity of staff and to accommodate additional hospital visits when a heat warning (i.e. the average of today's 14:05h temperature and tomorrow's forecasted high is ≥ 34℃ at Abbotsford or ≥ 29℃ at Vancouver) or a special weather statement for hot weather (i.e. when temperatures ≥ 32℃ are expected for at least two consecutive days at Abbotsford, Hope or Pitt Meadows weather stations) is released by Environment Canada.

The building design will be scored on the following measurements/statements:

- Provisions to protect the health, well-being and productivity of staff, particularly those exposed to the outdoor environment, e.g.;
  - Inclusion of shade in outdoor areas where staff may frequent
  - Provisions in the design to prevent disruptions to building services due to heat
- The extent to which the space is adaptive, to enable the treatment of patients with complications due to extreme heat, e.g.;

    - Areas that are adaptive to prevent exposure to direct sunlight
    - Appropriate equipment to enable treatment of complications

- Other provisions that enable the hospital to operate efficiently during extreme heat waves, e.g.;

    - Considerations for inpatients' and visitors' needs (such as availability of water)
    - Passive building design elements
    - HVAC systems control and integration

In this case, the Technical Submission would include a narrative, including any drawings, models, or other information required, proposing provisions that will help maintain the ability of staff to perform their duties without disruption as a consequence of heat and the expectation that heat will lead to an increased number of hospital visits.

Where a resiliency scored element is developed to award points for how effectively the proposal responds to the climate conditions in the PCIC weather files, a key reference is the Resilience Guidelines companion document *Establishing Design Conditions for Climate Resilient Planning & Design for Health Facilities in British Columbia.*

RFP Evaluation Model

The RFP Evaluation Model, as proposed by BC Housing's MBAR project, addresses a key issue: *How might we include risk and resiliency elements in a project without substantial changes to the existing budget?*

One idea is to engage prospective contractors to identify what is feasible to include within the budget and provide incentives for them to produce cost-effective ways of reaching desired standards.

Current budgeting practices effectively value future risk and resiliency at zero. The RFP Evaluation Model outlines how risk and resiliency objectives could be factored into a proposal's overall score, providing a way to account for the future value of including these elements at the outset of the project. The proposed approach would modify the net bidding price where the proposal addresses specified risk and resiliency measures of importance to the Project.

Table 5 below provides an example for addressing seismic resilience. At the 'S1' level, the estimated net present value (NPV) of building to a standard that would be reparable in 1 year in the case of an earthquake, is 10% of the overall project cost.

Table 5: *Example of an RFP evaluation model that considers seismic resilience[11] (Source: BC Housing).*

Hazard	Resilience Objective	Cost Impact Factor (CIF) (%)	NPV Impact Factor (%)	Importance Modifier (IM)	Resilience Credit (CIF*IM =RC%)
S1	Reparable within 1 year	0.3	10	1	0.3%
S2	Reparable within 3 weeks	0.8	20	1	0.8%
S3	No displacement from space.	1.2	30	1.1	1.32%
S4	No disruption to operation.	5	50	1.2	6%
S5	Existing buildings also upgraded to no disruption to operation.	10	60	1.5	15%

This provides insight for the client to determine the Importance Modifier (IM), which can be adjusted by the client based on NPV and any other factors influencing how important it is to meet that particular standard. The Cost Impact Factor (CIF) is an estimate of the added cost up front, to building to the S1 standard – in this case, it is estimated to add 0.3% to the cost of the Project overall. The CIF and IM combine to determine the Resilience Credit that would be applied to adjust their overall bid price, thereby incentivizing the proponent to include an efficient selection of desired risk and resiliency elements in the Project.

Additional benefits include drawing on the creativity, knowledge and expertise of the proponent to find cost-efficient ways to enhance resilience within project constraints; and advancing best practice in the field so that the knowledge and capacity to include these measures becomes more expected and widespread.

[11] Explanatory notes:

- Resilience Enhanced Design (or Design/Build) must still be achieved within Project Budget
- Resilience Credit = [Lesser of Cost and NPV Impact Factors] x Importance Modifier
- RFP Responses will be evaluated as if Proposed Contract/Tender Price = [100-Sum(RC%)]/100 x Actual Submitted/Tendered Project Price

4.3. Design & Construction Specifications

The following section outlines the Resilience Requirements that Design Teams will need to meet, along with associated Means of Compliance. Addressing climate risk and enhancing resilience crosses professional and technical boundaries, and so Requirements are presented by climate hazard to help encourage collaboration and cross-pollination of ideas. These include requirements that increase resilience in a broad sense, along with:

- Warming temperatures and extreme heat;
- Air quality impacts;
- Flooding;
- Power outages; and
- Chronic stressors, specifically water shortage and drought, moisture and humidity, freeze/thaw cycles, snowfall, and wind.

However, to better enable Design Teams to allocate responsibilities, the Resilience Requirements have also been linked to generalized OPR categories based on those used across the Health Authorities:

- Facility Planning
- Structural
- Architectural
- Mechanical
- Electrical
- Facility Configuration and Internal Circulation
- Envelope and Enclosure
- Plumbing and Storm/Sewer
- Landscape
- Operations

Note that not all of the above categories are represented within the requirements, but that the same approach is applied across the resilient design strategies presented in Section 8.

General Resilience

#	Requirements	Means of Compliance	OPR Category
1.01	This section will be read in conjunction with the following sections and schedules: • Design Life Table; • LEED Innovation Credit IPpc98: Assessment and Planning for Resilience; • Schedule for Energy and Carbon Guarantees; • General Resilience; • Structural; • Architectural; • Mechanical; • Electrical; • Facility Configuration and Internal Circulation; • Envelope and Enclosure; • Plumbing and Storm/Sewer; • Landscape; and • Operations.	N/A	General Resilience
1.02	Design Team to provide definitions and interpretations of the following (at a minimum): • Climate hazard • Climate impacts • Design criteria / conditions / parameters • Future climate projections data / Future projections of climatic design data • Implementation (or adaptation) pathway • Threshold of risk • Resilience priorities for the project	Submit a list of definitions and interpretations	General Resilience

1.03	Data and information sources for priority climate hazards and future projections data include at minimum:
	• Relevant Health Authority resources including:
	  o Climate Hazard Exposure Screen
	  o Climate Hazard Reference Document Summary
		N/A	General Resilience

	o Preliminary Climate Risk Assessment report o Net Zero Emissions and / or Energy Ready by 2050 Feasibility Study • Preliminary Strategic Climate Risk Assessment for BC (CAS, 2019)		
1.04	Information sources for the Climate Risk Assessment Workshop methodology include at minimum: • Climate Resilience Guidelines for Health Facility Planning & Design • Climate Lens (Infrastructure Canada) • NYC Climate Resiliency Design Guidelines 2019	N/A	General Resilience
1.05	Future climate projections for priority hazards will inform the design, development and renewal strategies of the facility, buildings (including orientation, exposure and materials selection), critical building systems and their associated components, through to end life.	N/A	General Resilience
1.06	A full-day Climate Risk Assessment Workshop will be carried out by each Project proponent, as outlined in the Climate Resilience Guidelines for Health Facility Planning and Design, to: • Build knowledge and competence; • Better understand climate vulnerability and risks; • Present new data and information from technical studies; • Help proponents to understand Project specifications, including the intent and expected outputs; • Reinforce importance of resilience requirements to the Health Authority; • Validate the inputs and outputs of the Climate Hazard Exposure Screenings and the Preliminary Climate Risk Assessment (including design strategies), and identify improved or additional strategies to reduce risks and build resilience, from a builder and constructability perspectives; • Prioritize design strategies and adaptation pathways that reduce climate risks and increase resilience to facility end life; • Present equal-or-better solutions to the project specifications; • Inform Schematic and Detailed design stages; and • Identify any gaps or questions for the Health Authority and/or Compliance Team to address.	Submit a narrative that describes how project will achieve the objectives listed within this requirement	General Resilience
1.07	Exterior and interior designs will seek to achieve health and climate co-benefits by prioritizing green design strategies described in the following:	Submit a narrative that describes how project will achieve health and climate co-benefits by prioritizing green design strategies	General Resilience

	• Greening Blocks: Practical Design Interventions to Integrate Health and Climate Resilience Co-Benefits 2019; • Green Infrastructure and Health Guide 2018; • Healthy Built Environment Linkages Toolkit 2018; and, • Climate2050 Health and Well-Being Roadmap (Metro Vancouver).		
1.08	Design Team to design the Facility to: • Give priority to efficient use of resources, protection of health and indoor environmental quality; • Take advantage of efficiencies and innovations achieved through integration of systems and scheduling of climate resilience measures in accordance with Facility half-life and full-life to minimize operational and lifecycle costs for the Owner (for example in relation to utilities); • Take advantage of alternative sources of energy such as passive solar, and on-site power generation and opportunities for waste heat recovery; and • Ensure that no materials are used on the interior of the Facility that are detrimental to human health.	Submit a narrative that describes how project will achieve the objectives listed within this requirement	General Resilience
1.09	A section in the design and construction package will be dedicated to climate risks and resilience. This section will (i) list the buildings, critical building systems, and their associated components that require modification to account for the increased variability, extremes, frequency, duration, and unpredictability of weather events associated with a changing climate to facility end-life; and, (ii) describe the following: • Changes in temperature, precipitation and other climate variables identified as relevant in the climate hazard exposure analysis; • Adjustments to design criteria, parameters and / or conditions as a result of the changes in climatic variables noted above; • The type and extent of design modifications to account for climate change to facility end life; • Climate-related assumptions and risk thresholds that underpin proposed designs; and • Data and information sources used for proposed designs.	Submit design and construction package with section dedicated to climate risks and resilience, including lists and narratives as described	General Resilience

1.10	Design conditions used for sizing the above systems are to be based on the year 2050 climatic design data and weather file conditions produced by PCIC. For the purposes of designing for cooling conditions (i.e. 97.5% or 99% percentile summer temperature depending on location and class of facility as per CSA 317.02), as well as allowance for future provisions, the following climatic design data and weather files for dry bulb and wet bulb temperatures and enthalpies will be used: a) Year 2050 b) Year 2080	N/A	General Resilience
1.11	For determined capacity of the equipment that will be designed/installed in future (associated with facility end life), the Design Team will use future climate projections provided via the Owner from a reputable source, such as the Pacific Climate Impacts Consortium (PCIC).	Submit confirmation of source for future climate projections used for design	General Resilience
1.12	Where component and system design life are shorter than the design life of the Facility, the Design Team will plan and construct a flexible implementation pathway as per future climate projections, such that they can be readily replaced, upgraded, added to or retrofitted through to component and assembly end life.	Submit a narrative of flexible implementation pathway that outlines equipment replacement, upgrade, additions and/or retrofits	General Resilience
1.13	Develop an *Asset Management Plan* that includes guidance for the following in future climate conditions: a) Maintenance b) Renewals c) Operations Integrate this plan with the facility's Building Information Modelling (BIM) processes.	Complete an *Asset Management Plan* with narratives and annotated drawings as appropriate	Facility Planning
1.14	Develop a *Building Durability Plan* consistent with CSA 478 that includes consideration of future climate projections. Within this document: • Produce a design life table specifying component lifespans to indicate durability and longevity • Indicate where components achieve longer service lifespans	Complete a *Building Durability Plan* with tables and annotated drawings as appropriate	Facility Planning

1.15	Develop a Contractor Quality Management Plan that demonstrates: • How construction materials will be kept dry throughout the construction process • How products that will be contained within the building envelope will be kept dry before being sealed in place • How dust and contamination of construction will be managed	Complete a *Contractor Quality Management Plan* with narratives and annotated drawings as appropriate that identify management approaches for both moisture and dust	Facility Planning
1.16	Provide a building envelope design that is informed by hazard exposure analysis and future climate projections to facility end life.	N/A	Envelope & Enclosure
1.17	Ensure the building envelope minimizes thermal bridging.	Submit annotated drawings as appropriate	Envelope & Enclosure
1.18	As part of building enclosure commissioning, conduct air barrier testing and specify minimum leakage for building envelope.	As part of the commissioning process, submit compliance reports for air barrier testing	Envelope & Enclosure

Warming Temperatures & Extreme Heat

#	Requirements	Means of Compliance	OPR Category
2.01	Develop an *Extreme Heat Management Plan* that demonstrates: • How the project has considered future climate projections based on data provided by climate science authorities (e.g. PCIC) • How future weather files have been used to augment energy modelling • Minimum and maximum temperature ranges for critical and non-critical areas of the facility • Measures in place to ensure overheating hours do not exceed acceptable limits over facility design life • Overall approach to temperature regulation (e.g. active and passive shading)	Submit an *Extreme Heat Management Plan* with narratives and annotated drawings as appropriate, including modelling results using future weather files	Facility Planning
2.02	Conduct a modelling study to identify opportunities to minimize sensible cooling demand, including but not limited to: • Exterior shading (passive and active) capable of blocking 100% of solar gains between the months of March and September • Appropriate window-to-wall ratios • Enhanced insulation • Enhanced glazing that minimizes incident solar radiation • Thermal mass feasibility (e.g. ground, water in ground)	Submit modelling results with narratives and annotated drawings as appropriate that summarize measures included to minimize latent cooling demand	Facility Planning
2.03	Design conditions for 1%, 2.5% and 5% defined by CSA Z317.2 concerning 'airflow and design parameters during facility catastrophic events management' shall be strictly 'enthalpy based' peaks, extrapolated for PCIC weather files that provide hourly based dry bulb and wet bulb conditions.	N/A	Mechanical
2.04	Equipment and plant(s) sizing for catastrophic event management mode, CSA Z317.2-15 Section 6.16 applies. Use Figure 3 ('airflow and design parameters for catastrophic events management') for Class A-1 Health Care Facilities with the following exception(s): Type I areas to maintain 100% of the airflow; and Type 1 and Type 2 areas are operating on 100% outdoor air systems.	N/A	Mechanical

2.05	Size and design facility cooling systems (i.e. chiller plant and ventilation air handling unit equipment and plants) to maintain required thermal comfort using weather files for the year that is 30 years from Facility commencement date. Use future weather files provided by the Owner, possibly sourced from the Pacific Climate Impacts Consortium (PCIC).	Submit confirmation of source for future climate projections used for design	Mechanical
2.06	Design and construct the Facility's main infrastructure (including but not limited to ductwork and piping network, and terminal units and associated coils such as VAV boxes) for opening day to be sized for future climate conditions, using future weather files that are relevant to facility end life.	Submit a narrative that describes how opening day equipment will be made relevant to facility end life	Mechanical
2.07	Allow for mechanical cooling equipment upgrades to end of Facility life to account for changing climatic conditions. Ensure there is adequate space allocated for future upgrades in mechanical rooms and on the roof.	Submit a narrative that describes the potential equipment upgrade pathway for 2050 and 2080, and include annotated drawings showing the locations allocated for future equipment	Mechanical
2.08	Provide means of passive cooling strategies to reduce demand on cooling plant and other infrastructure, ensuring that these strategies are economically practical.	Submit narrative of approach to passive design, including annotated drawings as appropriate	Envelope & Enclosure
2.09	Ensure that landscaping reduces the local urban heat island effect and enhances resilience to extreme heat through: • Master-planning of greenspace • Layout and form that encourage airflow • Heat- and drought-tolerant planting Based on the above, highlight how greenspace has reduced cooling loads and how vegetation has provided outdoor areas of respite from high temperatures.	Submit landscaping plan and plant list, with narratives and annotated drawings as appropriate	Landscape

Air Quality Impacts

#	Requirements	Means of Compliance	OPR Category
3.01	Develop an *Air Quality Management Plan* that demonstrates: • Overall approach to maintaining indoor air quality to account for current conditions (i.e. business-as-usual, wildfires smoke, pandemic) • Maximum levels of indoor air contaminants in critical and non-critical areas of the Facility • Measures in place to ensure levels of indoor air contaminants do not exceed acceptable limits over facility design life	Submit an *Air Quality Management Plan* with narratives and annotated drawings as appropriate	Facility Planning
3.02	Design air handling units to accommodate additional sections and/or filters (e.g. activated carbon, MERV 14 at a minimum) capable of removing smoke particulate during wildfire smoke events. Ensure spaces are programmed to allow for adequate storage of additional filters.	Submit a narrative that describes approach to enhancing filtration during wildfire smoke events, including annotated drawings as appropriate	Mechanical
3.03	Design Facility to include common interior spaces (e.g. lobbies) that may be converted expediently to 'refuge areas' with cool and clean air. Equip these areas with dedicated HVAC systems sized for 100% outdoor air capacity that may accommodate community surge for up to 14 days during extended periods of wildfire activity.	Submit a narrative that describes approach to providing 'refuge areas' with cool and clean air, including annotated drawings as appropriate	Facility Planning
3.04	Limit exfiltration and infiltration of air, wildfire smoke, fine particulate matter (<2.5PM) and other air pollutants through materials of the assembly, joints in the assembly, joints in components of the wall assembly, and junctions with other Facility elements, including the roof.	Submit a narrative that describes approach to limiting exfiltration and infiltration through assembly, including annotated drawings as appropriate	Envelope & Enclosure
3.05	Where possible, locate air intakes on north and east facades and in a protected locations to minimize intake of contaminants (i.e. avoid pollutants near air intake locations, including plantings, parking areas, garbage disposal bins, and others).	Submit annotated drawings showing and describing air intake locations	Mechanical
3.06	For perimeter zones (i.e. zones that are subject to outdoor air conditions), size ventilation rate to the greater requirement of CSA Z317.2 air change rates or the air change rate necessary to meet the Facility end life cooling requirement.	Submit a narrative that describes approach to maintaining appropriate ventilation rate for perimeter zone, including annotated drawings as appropriate	Mechanical
3.07	Provide atomizing humidification systems to achieve 40 to 60% relative humidity in all areas of the facility requiring humidification.	Submit annotated drawings showing humidity sensor locations	Mechanical

3.08	All regularly used exterior entrances to the Facility will have a vestibule as specified. These vestibules will: • Use doors that will be motion-sensor activated by push-button controls, and equipped with manual override controls located on the inside and outside of the doors, to be activated in the event of adverse outdoor air quality • Provide double entries for high traffic areas, such as emergency rooms and loading bays, to minimize smoke and particulate matter ingress in the event of adverse outdoor air quality • Provide means to control pressure differential between building, vestibule and exterior • Be positively pressurized relative to atmospheric pressure to minimize infiltration • Be designed as not to impede wayfinding, and movement by wheelchairs and stretchers	Submit annotated drawings showing approach to vestibule design, and include a narrative of how pressurized vestibules will be tested in different seasons by pressure sensor or by tracer smoke	Facility Configuration & Internal Circulation
3.09	Conduct whole building air leakage testing prior to occupancy to ensure leakage is under 1.27L/m2 @ 75 Pa. In conjunction with this test, conduct an infrared scan to identify potential leakages and complete duct leakage testing.	As part of the commissioning process, submit compliance report with modelling results, including narratives and annotated drawings as appropriate that summarize measures included to reduce air leakage For infrared scan, include photographic evidence that the scan as been conducted	Envelope & Enclosure
3.10	Monitor and communicate indoor air quality to staff. Monitor and communicate outdoor air quality to staff and patients.	Submit a narrative that describes how air quality will be continuously monitored and communicated	Operations

Flooding

#	Requirements	Means of Compliance	OPR Category
4.01	Conduct a risk assessment to determine site-level flood risk, along with any existing requirements (e.g. flood construction levels or FCL, minimum elevations): • For urban (pluvial) flooding: Review local government documents for locally downscaled future climate data. Review the Provincial Stormwater Planning Guidebook for additional information on managing rainfall issues. • For riverine (fluvial) flooding: Review Provincial and regional flood maps and evaluate the highest magnitude freshet flood events for present day, 2050 with climate change, and 2100 with climate change. • For sea level rise: Review local government documents and the Provincial Sea Level Rise Adaptation Primer, which recommends taking the following numbers into account for sea level rise: 0.5m for 2050, 1m for 2100 and 2m for 2200. Evaluate sea level rise needs alongside storm surge effect.	Complete a risk assessment report detailing the kinds of flooding the project is at risk of, as well as the sources of information used to derive conclusions	Facility Planning
4.02	Develop a *Flood Management Plan* that demonstrates: • Overall approach to flood mitigation (e.g. resist flooding, accommodate flooding) • Current flood construction level (FCL) and design to withstand anticipated pressure If resisting flooding: • Design basement structure and envelope to ensure they are waterproofed and/or watertight • Consider back-up measures if flooding occurs If accommodating flooding: • Locate and/or protect of key systems (i.e. electrical, mechanical) and services (e.g. elevator pits, circulation, back-up power) • Identify areas that can be repurposed before, during and after flooding (e.g. for retention) • Plan to minimize effort and reduce time associated with water removal and clean-up (e.g. site grading, pumps, water-resistant materials) • Specify suitable materials in flood area for easy cleaning, repair or replacement • Ensure occupant safety and critical hospital functions during flood events	Complete a *Flood Management Plan* with narratives and annotated drawings as appropriate	Facility Planning

4.03	Develop a *Stormwater Management Plan* for the site that demonstrates how the project will: • Limit post-development 10-year flow rate from on-site discharged to the off-site storm sewer will be no greater than the 10-year pre-development flow rate, with pre-development flow rate based on 2014 IDF curves and post-development flow rate based on 2100 IDF curves to account for climate change. • Ensure that infiltration, capture and conveyance systems account for adjusted climate projections based on 100-year IDF curves for end of facility life. Where site-specific updated future IDF curves do not exist, add 20% to rainfall intensity for a nominal factor of safety. • Ensure proper site drainage so that rain, snowmelt and freeze/thaw is prevented from entering the building and from pooling on site, typically achieved through increased soil infiltration, decreased impervious surfaces, and grey infrastructure such as retention tanks. • Capture and 'treat' 90% of average annual rainfall volume on site. • Limit transference of sediment and contamination to neighbouring sites.	Complete a *Stormwater Management Plan* with narratives and annotated drawings as appropriate, including modelling results using IDF curves	Facility Planning
4.04	Incorporate waterproofing strategies into below grade concrete in accordance with geotechnical conditions, and demonstrate how the project team will: • Reduce water infiltration directly adjacent to the buildings foundation, especially if a below grade structure is present • Apply moisture and vapour barriers to below grade concrete to prevent moisture problems • Design for service life of the building • Ensure verification during construction • Ensure coordination with all other building systems and penetrations	Submit a narrative that describes waterproofing strategies, including annotated drawings as appropriate	Envelope & Enclosure
4.05	Use site grading to direct water away from buildings, and permeable paving materials to improve overall rainwater infiltration capacity of the site.	Submit landscaping plan with narratives and annotated drawings as appropriate	Landscape
4.06	Account for future climate projections in the design of roof drainage and rainwater leaders. Capacity of design should be increased by an additional 20% above current municipal bylaw requirements.	Submit annotated drawings showing roof drainage system and highlighting capacity	Envelope & Enclosure

Power Outage

#	Requirements	Means of Compliance	OPR Category
5.01	Develop an *Emergency Power Supply Management Plan* that identifies: • Power requirements for different parts of the Facility, including clinical functional rooms and inpatient rooms • Critical and non-critical loads throughout the Facility, including building systems • Approach to providing back-up power and fuel to allow the Facility to operate for at least 72 hours in the event of an emergency, as per CAN/CSA Z32 • Approach to ensuring redundancy in back-up power (i.e. minimum of two back-up power systems and required fuel) • Approach to ensuring that back-up power sources are resilient to climate-related hazards (e.g. extreme heat events, flooding)	Complete an *Emergency Power Supply Management Plan* with narratives and annotated drawings as appropriate	Facility Planning
5.02	Conduct pre-development modelling and post-development testing to ensure the efficacy of back-up power systems: • Within the energy model, simulate a power outage and demonstrate building conditions under this scenario (e.g. power usage, temperature) • Ensure that interior temperature does not exceed defined maximum temperatures for different areas of the facility (as per ASHRAE 55) under future climate scenarios (e.g. RCP 8.5 in 2050) • Perform monthly testing of generators	Submit modelling results with narratives and annotated drawings as appropriate that summarize building conditions during a power outage Submit commissioning reports for generator testing	Electrical
5.03	Conduct a site-wide renewable energy feasibility study to assess power supply, availability and renewable energy options. At a minimum: • Ensure Facility is 'solar-ready' (i.e. designed to accommodate the installation of solar panels, even if it doesn't take place at time of construction) and place mechanical equipment placed at north end of roof • Ensure site structures are solar-ready and are designed for access to a power supply • Ensure Facility is 'battery-ready' (i.e. design for easy installation of batteries in the future) by considering future space and location requirements for on-site battery storage	Submit study results with narratives and annotated drawings as appropriate	Facility Planning
5.04	Ensure building management systems (BMS) and/or electrical infrastructure is designed to allow for segregation of loads.	Submit a narrative that describes the approach to load segregation	Electrical

5.05	Design electric vehicle (EV) charging infrastructure on the site to facilitate power sharing (i.e. capable of sharing the energy storage in EV batteries with the facility when needed).	Submit a narrative that describes the approach to power sharing	Electrical
5.06	Provide Level 3 EV charging infrastructure in 50% of ambulance parking stalls.	Submit annotated drawings showing EV charging infrastructure locations	Electrical

Chronic Stressors: Water Shortage & Drought

#	Requirements	Means of Compliance	OPR Category
6.01	Develop an Emergency Water Shortage Plan that demonstrates: • Risk assessment of compromised water supply and/or lower water pressure under different future climate scenarios • Water use survey of operational needs by department, along with formalized hierarchy of use under constrained conditions • Water conversation measures to reduce demand • Based on risk assessment and survey results, identify appropriate amount of on-site storage for potable and process water, including potential for rain/grey water systems	Complete an *Emergency Water Shortage Plan* with narratives and annotated drawings as appropriate, including modelling results using future weather files	Facility Planning
6.02	Provide landscape plans that demonstrate how the project will reduce potable water used for irrigation, covering topics such as maintenance, water availability, irrigation methods. If used, all extensive green roof areas are to have low maintenance requirements and be appropriate for the micro-climate of each roof area.	Submit landscape plans with narratives and annotated drawings as appropriate that highlight strategies for potable water used for irrigation	Landscape
6.03	For all planting at the project, select plants that are non-invasive and drought-tolerant, and that generate limited pollen. All plant selections should be appropriate for the current and projected micro-climate conditions of the site. For optimal health and climatic co-benefits (e.g. urban heat island effect reduction), selections should enhance natural canopy at the site an incremental rate of 10% per year until 40% coverage is attained.	Submit plant list that explains plant selection, along with narrative illustrating pathway towards 40% natural canopy coverage	Landscape

Chronic Stressors: Moisture & Humidity

#	Requirements	Means of Compliance	OPR Category
7.01	Ensure chiller plant is sized to account for future humidity loads and rather than historical conditions. Consider alternate methods of dehumidification (e.g. desiccation) to reduce loads on the chiller.	Submit a narrative that describes the approach to managing humidity loads, including annotated drawings as appropriate	Mechanical
7.02	Design for relative indoor humidity of between 40% and 60% (note that code dictates 30-60%), using future climate projections to guide design.	Submit a narrative that describes the approach to maintaining relative indoor humidity between the specified range	Mechanical
7.03	Demonstrate how condensation will be passively managed throughout the building envelope and under future climate conditions over the lifespan of the Facility (i.e. without need for mechanical systems under power outage).	Submit a narrative that describes the approach to managing condensation, including annotated drawings as appropriate	Envelope & Enclosure

Chronic Stressors: Freeze/Thaw

#	Requirements	Means of Compliance	OPR Category
8.01	In areas where permafrost is a consideration, carry out a study of impacts to permafrost due to climate change and document overall approach to permafrost management and ensuring structural stability: a) Keep soil frozen b) Keep soil thawed c) Isolate project from active layer	Submit permafrost study results with narratives and annotated drawings as appropriate that summarize measures to ensure structural stability	Structural
8.02	Use high-performance insulation and air sealing to eliminate the escape of heat from conditioned areas. Locate exhaust away from enclosure materials which are susceptible to high humidity micro-climates.	Verify high-performance insulation at time of construction, working closely with contractor to ensure that proper materials and practices are used	Envelope & Enclosure

Chronic Stressors: Snowfall

#	Requirements	Means of Compliance	OPR Category
9.01	Conduct a site-wide snow study that includes all buildings and demonstrates: • How the project has considered historic and future snowfall projections (i.e. likely range of snowfall increase or decrease) • How the project will account for changing properties of future snowfall (e.g. heavier/wetter snowfall in some areas) • For locations where snowfall is projected to increase, how the building design will account for increased snow loads; In this, do not assume that a current safety factor (e.g. 1.25 for buildings classified as 'post-disaster') amounts to future-proofing for extreme events • Consideration of snowfall impacts of beyond the Facility, including localized flooding, transportation disruptions, etc. • Consideration of the impacts of wind exposure and snow drifting, and how to protect pedestrian movement and ensure that all spaces remain accessible	Submit snow study results with narratives and annotated drawings as appropriate	Facility Planning
9.02	Develop a site-wide *Snow Management and Safety Plan* that demonstrates: • Approach to ensure that snowfall is quickly cleared to allow safe access and movement around the site • Confirmation of whether the facility has its own equipment/resources or will rely on an external contractor • Identification of locations where snow will be stockpiled • Approach to addressing snow and icicles falling off roofs, and potentially creating a hazard for pedestrians and blocking entrances The Plan should include: • Whether snow can be safely removed from the roof in a timely manner • Confirmation that the Plan does not create unbalanced snow loads • Occupational health and safety and fall protection requirements • How and when retrofit structural evaluations and strengthening are required when a roof is found to need frequent snow/ice removal • Barrier placement to protect the public, if required	Complete a *Snow Management and Safety Plan* with narratives and annotated drawings as appropriate	Facility Planning

9.03	Where required for safety and not addressed by alternative approaches, include snow melting systems for critical entry points (e.g. helipads, loading bays). In exterior sloped areas (e.g. ramps), include radiant heating, hydronic heating systems, or heat tracing, ideally sourced from waste heat.	Submit annotated drawings showing snow melting system locations and features	Architectural

Chronic Stressors: Wind & Storms

#	Requirements	Means of Compliance	OPR Category
10.01	Conduct a site-wide wind study that includes all buildings and demonstrates: • How the project has considered present and future wind velocities based on data provided by climate science authorities (e.g. PCIC), noting that wind projections will vary greatly; In this, do not assume that a current safety factor (e.g. 1.25 for post-disaster buildings) amounts to future-proofing for extreme events • Assumed forces and wind pressures for base building design, cladding design, sections and roofs • Potential hazard areas and features (e.g. trees, overhangs) • Measures in place to keep building materials and site elements (e.g. lighting, signage, exterior shades, canopies) secure, so that they do not become projectiles during extreme wind events • Areas where impact-resistant materials could be used • Implications for rooftop equipment and renewable energy systems (e.g. solar PV) • If wind study results are more onerous than the BC Building Code, this study will take precedence.	Submit wind study results with narratives and annotated drawings as appropriate that summarize measures to mitigate wind risk	Facility Planning
10.02	If wind speed thresholds (to be defined) are projected to be exceeded, include site-level measures to protect pedestrians (e.g. wind breaks, buffers) and access areas (e.g. loading docks, door assemblies, vestibules, ambulance bay).	Submit narrative and annotated drawings as appropriate	Architectural
10.03	When locating equipment on the roof cannot be avoided, all rooftop equipment is to be constructed to withstand the year 2050 wind loads as per future climate projections. Approaches to include installation of protective barriers and bolting down of all equipment.	Submit narrative and annotated drawings as appropriate	Mechanical

5. CONSULTANT PROCUREMENT

This section outlines the primary considerations and processes that should be considered in consultant procurement for projects developed following the Resilience Guidelines.

5.1. Consultant Contract Amendment

Existing contracts can be amended as per guidance below, provided by Island Health:

Schedule A: Services

The Consultant shall consider the changing climate in the design of building systems and associated components. In conjunction with the *BC Building Code*, ASHRAE, or other industry accepted sources of climatic design data, the Consultant shall use data that reflects current and future climate over the service life of the equipment and building systems to inform design. When energy modelling is required to inform design, models shall use existing weather files (e.g. Canadian Weather for Energy Calculations file (CWEC)) as well as similar files adjusted6 to reflect climate over the service life of the equipment and building system being modelled.

The Contractor shall use climate Projections based on RCP 8.5*, unless a risk assessment indicates a lower RCP is acceptable. The recommended sources for this information are:

- Pacific Climate Impacts Consortium (PCIC) Plan2Adapt tool, Climate Explorer and adjusted weather files
- ClimateData.ca
- BC Climate Explorer
- Centre for Forest Conservation Genetics (CFCG) ClimateBC Map
- Engineers and Geoscientists BC (EGBC) Climate Change Information Portal

The Contractor shall use climate projections, their professional judgement, and consultation with stakeholders to determine what changes are required in the equipment and/or building system design to account for the changing climate over the asset's entire life cycle. The design professional shall document, in a dedicated section of the design and specification package, the following:

1) Changes in design temperature, precipitation, and other relevant climatic design variables anticipated over the project's life-cycle citing the source(s) of that data; and
2) A narrative, to be included in specifications and drawings, to explain what adjustments were made to design criteria and how equipment and building system designs were modified to account for climate change, including all assumptions. If no modifications are required, this must be justified.

This information shall be provided for review and approval by the Health Authority, at the milestones outlined in the Resilience Guidelines. If the project requires a formal business case, costs associated with designing for a changing climate must be included.

Sample Change to Climatic Design Data Value (for illustrative purposes only)

If BC Climate Explorer indicates that the climate variables most closely related to the climatic design data of interest in the BCBC are Projected to increase 15% by 2050, then it would be reasonable for the design professional to increase the BCBC value by 15% when designing an asset in service to 2050.

Additional Resources

- Engineers Canada's *Principles of Climate Adaptation and Mitigation for Engineers*

- Ministry of Transportation and Infrastructure (MoTI) *Resilient Infrastructure Engineering Design Technical Circular T-04/19*

For more information or assistance, contact the Pacific Climate Impacts Consortium at https://www.pacificclimate.org/ to consult with climate specialists to ensure that interpretations of climatic information used in professional practice reasonably reflect the most current scientific consensus regarding the climate and/or weather.

5.2. Climate Services and Adaptation Consultant

There are three recommended approaches to navigating the Climate Risk Assessment process (described in Section 6):

1) Co-produce process with Regional Climate Service Provider
2) Procure a Climate Adaptation Consultant to lead the process
3) Co-produce process with Regional Climate Service Provider and third-party consultants

The suitability of each will depend the specific project and the availability of consultants.

OPTION A: Co-production Project with Regional Climate Service Provider

Key Responsibilities

1) Define map domains and locations of interest for tables based on basic climatology and priority areas
2) Produce tables of projected climate change for the 2020s, 2050s, and 2080s under future climate scenarios (e.g. RCPs 2.6, 4.5, and 8.5).
3) Generate detailed maps for selected locations of 2050s change under one scenario using an ensemble of statistically downscaled global climate models (GCMs) (e.g. with BCCAQ) and bias-corrected to 800m with PRISM for a pre-defined set of variables, such as:
    - Daytime high and nighttime low temperature and precipitation
    - Heating, growing, and cooling degree-days
    - ~30 CLIMDEX indices of climate extremes
    - 1-in-20-year return periods one-day events
    - ~20 *BC Building Code* and/or ASHRAE indices for the site locations
4) Attend and present at Preliminary Climate Risk Assessment Workshop (see Section 6.2), and assist with planning and design of that workshop
5) Assist with the co-development of climate impacts report and interpretation of results through conference calls and review of written materials

Key Competencies

- Production of downscaled climate projections
- Localized adjustment using 800 m PRISM high resolution climatology
- Ensure that impacts assessment relies on accurate interpretation of future projections

OPTION B: Climate Adaptation Consultant

Key Responsibilities

1) Obtain climate Projections from previously published reports and/or online data portals (e.g. PCIC Climate Explorer or ClimateData.ca)

2) Produce tables of projected climate change for the 2020s, 2050s, and 2080s under future climate scenarios (e.g. RCPs 2.6, 4.5, and 8.5).
3) Generate detailed maps for selected locations of 2050s change under one scenario using an ensemble of statistically downscaled global climate models (GCMs) (e.g. with BCCAQ) and bias-corrected to 800m with PRISM for a pre-defined set of variables, such as:
    a. Daytime high and nighttime low temperature and precipitation
    b. Heating, growing, and cooling degree-days
    c. ~30 CLIMDEX indices of climate extremes
    d. 1-in-20-year return periods one-day events
    e. ~20 *BC Building Code* and/or ASHRAE indices for the site locations
4) Attend and present at Preliminary Climate Risk Assessment Workshop (see Section 6.2), and assist with planning and design of that workshop
5) Produce project report

Key Competencies & Experience

- Previous adaptation project experience
- Experience accessing, summarizing, and working with future climate projections
- Project management
- Report writing
- Workshop organization

OPTION C: Co-production with Regional Climate Service Provider & Third-party Consultants

5.3. Climate Risk Assessment Consultant

Each Climate Risk Specialist shall have:

- A minimum of five years of work-related experience;
- Advanced education in one, or several, of the following fields: engineering, science or planning backgrounds, geology, geochemistry, physics, geophysics, climatology, meteorology, or related field;
- Knowledge of methods, tools, and approaches to evaluating and mitigating the risks and vulnerability of infrastructure to climate change; such as experience in the application of PIEVC, BARC or Infrastructure Canada Climate Lens assessments, or similar ISO 31000 or ISO 1409x series method application.
- Understanding of methods and tools used in climate modelling, and
- Experience with similar Projects in BC or Canada, preferably; or North America.

It is also strongly preferred that the Climate Risk Specialist have experience in the application of climate risk assessments in healthcare sector.

5.4. Resilience Compliance Audit Consultant

Where an Independent Resilience Consultant to engage on an ongoing basis throughout Design and Construction is not appropriate or cannot be secured, a Climate Resilience Compliance Audit Consultant supports the Owner at the final step of the Climate Risk Assessment process (see Section 6.4) to audit documentation at each submittal stage to:

- Verify that the detailed design will sufficiently address material climate hazard risks as identified in the Climate Risk Assessment, meet Owner's Project Requirements and Project Agreement, and confirm any equal-or-better alternatives with supporting justification and documentation as required;
- Determine compliance with other resilience-, emissions reduction- and sustainability-related requirements as stated in the Design and Construction specifications;
- Ensure that design strategies optimise health and climate co-benefits as per the High Level Master Plan;
- Confirm cascading benefits to the broader community of care with respect to:
- reducing exposure and / or sensitivity of community;
- increasing adaptive capacity of community;
- ensure resilience of critical infrastructure that supports the broader network of health service delivery connected to the facility, such as: Virtual Health, including telecommunications; power, water and sewerage utilities; and roads and public transit; and
- Optimize the opportunity to identify potential synergies and conflicts with GHG emissions reductions, seismic and pandemic resilience.

5.5. Independent Resilience Consultant

An Independent Resilience Consultant is one or more individuals who is acceptable to, engaged by and paid equally for by the Owner and Successful Proponent to carry out key responsibilities in the Construction or Design and Construction phases (i.e. as per procurement model). This role is an analogue to the Independent Energy Consultant role, as developed by Vancouver Coastal Health in 2019, and is intended to support health capital projects whereby key responsibilities include auditing progress and deviations from Energy and Carbon Targets for Design and Construction phases.

Key responsibilities include:

- Tracking progress over years;
- Flagging issues or material proposed changes, such as changes to Resilience Targets, with enough lead time for the Owner to respond;
- Reviewing proposed changes to Resilience Targets, and supporting justification;
- Review energy modelling studies that support resilience strategy implementation (e.g. interpretation, analysis, and any potential areas of concern); and
- Working directly with Compliance Team on behalf of the Owner to cross-check the Statement of Requirements with the Project Agreement.

6. CLIMATE RISK ASSESSMENT

Climate Risk Assessments consist of a number of important steps that vary slightly across different methodologies. This section describes a process that is informed by the *BC Climate Risk Assessment Framework*, *ISO 14090*, the *PIEVC Engineering Protocol*, the International Council for Local Environmental Initiatives Canada's (ICLEI) *Building Adaptive and Resilient Communities* (BARC) approach, Australia's *CoastAdapt*, among others.

Importantly, this process is shaped by Health Authorities' recent experiences and is expected to evolve over time with further application. Modifications to the process and tools likely will continue to be necessary on a project-by-project basis to ensure fit-for-purpose and alignment with context (e.g. pandemic). Shaped by procurement delivery model, availability of consultants and Health Authority capacity, among other factors, modifications may give rise to options and alternatives.

The Climate Risk Assessment comprises four key steps:

1) Climate Hazard Exposure Screen
2) Preliminary Climate Risk Assessment
3) Climate Risk Assessment Workshop
4) Climate Resilience Compliance Audit

Details for each step are outlined below including purpose, timing and responsibilities. Options and alternatives, such as a "quick starts" and short-cuts are provided in boxes throughout.

6.1. STEP 1: Climate Hazard Exposure Screen

What is the Climate Hazard Exposure Screen?

Hazard exposure screening is a process whereby the key climate-related hazards relevant to a site and its community are identified. It makes use of high-level screening process makes use of available climate and other data at regional and local scales. This process gives an early indication of the project's **vulnerability**, which is a function of three factors:

- **Exposure:** The nature or degree to which people or systems are exposed to a climate-related shock or stress (e.g. low-lying coastal homes are exposed to coastal flood risk while Burnaby campus is not);
- **Sensitivity:** The degree to which people or systems are either positively or negatively impacted by changing climate conditions (e.g. individuals with pre-existing respiratory conditions are generally more sensitive to smoke events and older buildings are generally more sensitive to overheating); and
- **Adaptive capacity:** The ability to prepare for and respond to impacts and consequences (e.g. a system that is already under stress has lower adaptive capacity).

The exposure screen ensures that key decision-makers, owners and operators of critical infrastructure are aware of a project's level and type of exposure from opening day and to facility end-life. A project's exposure to relevant climate-related hazards varies based on its location and setting, design features (e.g. orientation, materials), and off-site factors (e.g. public risk reduction measures such as dikes; availability of alternate, locally-based power sources such as a neighbourhood energy utility or micro-grid). Exposure can vary as hazards change, interact and compound. Impacts, vulnerabilities and risks also vary spatially and temporally as a result.

Subsequent technical studies inform the Business Plan by providing the detailed data, information and analysis required to develop an Indicative Design and a basis for project requirements. These ensure that a complete information set is available for both the Preliminary Climate Risk Assessment (see Section 6.2) and follow-up Climate Risk Assessment Workshop (see Section 6.3).

When should the Climate Hazard Exposure Screen happen?

A Climate Hazard Exposure Screen must be undertaken **upon approval for a Project to proceed to the Concept Plan phase** to inform location identification, options analysis, conceptual design development, and more accurate construction cost estimates. The results and recommendations should also be integrated into the relevant High Level Master Plan to ensure that it contains the most current information.

An exposure screen should also be undertaken upon development of a new High Level Master Plan. Where climate hazard information in existing High Level Master Plans is more than five years out of date, an exposure screen should be carried out due to the continuous improvement of climate science.

Responsibilities

The Health Authority is responsible for conducting the exposure screen to inform project site selection and to support the Indicative Design Team in carrying out the Preliminary Climate Risk Assessment (see Section 6.1).

Expected Results & Outputs

The Climate Hazard Exposure Screen results in a clear and concise summary of climate hazards and trends over time in Site and Facility Plans.

Specifically, exposure screen results should be integrated into the following documents:

1) High Level Master Plans, to inform site development in the context of a dynamic community of care and accelerating climate change. High Level Master Plans must have the contextual information required on climate hazards to understand potential impacts on the site, health service delivery area and broader health system over the medium to long-term.
2) Concept Plans, which must outline site options and cost estimates that account for climate hazards from opening day to facility end-life. Key information gaps are addressed prior to Business Plan initiation.
3) Business Plan and Indicative Design baseline information, including consultant RFP development (e.g. required skills and experience to carry out or incorporate technical study information) and proposal evaluations.
4) Preliminary Climate Risk Assessment (see Section 6.2) baseline information.
5) Broader discussion and collaboration with health system stakeholders for improved site and community level resilience.

Outputs should be provided in report and summary format: reports provide a robust evidence-base to support a wide variety of applications and decision-making, while summaries enable clear communication and effective engagement throughout the project. Specific reports include:

- A complete list of hazards reviewed, with hazards of concern indicated;
- Hazard likelihood and trends to facility end-life;
- Priority hazards for inclusion in subsequent steps;
- Data and information sources including a list of resources and experts; and
- Supplementary information and analysis required for the exposure review.

Next steps should ensure that the detailed data, information and analysis required to establish a baseline for design is available for Business Plan development. Specifically, subsequent technical studies are initiated **upon**

approval for a Project to proceed to the Business Plan phase. As the approval period may be extensive, the project teams and consultants responsible for developing the Concept and Business Plans may differ. It is carried out concurrent to Clinical Service Plan and Functional Program development. The timing is important to ensure that the baseline information required for Business Plan development is adequate and available. This includes development of the Request for Proposal (RFP) and evaluation of consultant submissions.

Key Steps & Information

Health Authority experience to date indicates that support from subject matter experts early in the process is highly valuable to ensure a reasonably clear and comprehensive understanding of climate hazard data from the outset. As many open source resources are available, it may be challenging for a non-expert to discern whether information is credible and useful. Experts in climate science, climate risk assessment and adaptation, and communicating and engaging on complex systems-level issues are particularly helpful.

Desktop Review

1) Conduct a desktop review of publicly-available reference documents or studies relevant to a health service delivery area. Note data and information gaps to be addressed. At minimum, resources should include:
    - Health Authority climate projections reports[12]
    - Scientific research from academic institutions and think-tanks (e.g. Pacific Climate Impacts Consortium, Prairie Climate Center)
    - Federal and Provincial reference documents or studies on different hazard types (e.g. Environment & Climate Change Canada; BC Ministry of Forest, Land and Natural Resources)
    - Regional or local municipal plans (e.g. Metro Vancouver Intensity-Duration-Frequency curves for stormwater, Cowichan Regional District water scarcity maps)
    - Community-level exposure from Health Authorities
    - Off-site critical infrastructure exposure analysis (e.g. Public Safety Canada *Critical Infrastructure Exposure Analysis*) and service agreements (e.g. power, telecommunications, water and sewerage utilities).This includes provisions for service guarantees in the event of e.g. a power outage exceeding backup and emergency generator fuel supply.
    - Reports from industry associations (e.g. Engineers and Geoscientists BC)
    - Ecosystem-level studies (e.g. watershed, airshed, floodplain)
    - Site-level technical studies (e.g. environmental, geo-technical)

Hazard Selection

1) Document climate hazards systematically, and add other relevant natural hazards as applicable.
    - Begin with the set of hazards in Table 6, based on those outlined in leading methodologies, including the *BC Preliminary Strategic Climate Risk Assessment Framework* and the Provincial

[12] *Advancing our Knowledge: Climate Change Impacts Interior Health Region* (Interior Health, 2020); *Moving Toward Climate Resilient Health Facilities for Fraser Health: Technical Briefing* (Fraser Health, 2019); Moving Toward Climate Resilient Health Facilities for Vancouver Coastal Health (Vancouver Coastal Health, 2018); *Nanaimo Regional General Hospital Climate Change Vulnerability Assessment Report* (Island Health, 2017)

Hazard, Risk and Vulnerability Assessment (HRVA) modernization project, and cross-checked with those required by for LEED Resilient Design pilot credits.

  - Next, address or note any information gaps, and use a process of elimination to determine relevance to a site and community.

2) Note and annotate each hazard of concern with underlying rationale and reference material (i.e. name and content of each report or plan).

3) Describe hazards quantitatively and/or qualitatively, and develop short descriptions to enable clear and consistent communications (see example in Table 6).

  - Is the hazard acute (shock, single, discrete), chronic (stress, recurring, ongoing), or both?
  - What is the nature of the hazard (e.g. extremes and peaks, change in mean, change in variability)?

4) Consider other major natural hazards (e.g. seismic, pandemic) that may compound with climate shocks and stresses to amplify or complexify cascading impacts. It is important to identify their relevance to each project early in the process to ensure that synergies and/or conflicts with proposed resilient design strategies are considered in subsequent steps.

Table 6: *Examples of short hazard descriptions by category.*

Category	Hazard Description
Temperature	Warmer summer temperatures
	Increased humidity
	Warmer winter temperatures
	More frequent and severe extreme temperature events
Wildfire	Increased frequency and severity of wildfires
	Increased frequency and severity of wildfire smoke events
Sea level rise & Tsunami	Sea level rise
	Storm surge and storm tide
	Tsunami
Precipitation	More frequent and intense precipitation, leading to urban and riverine flooding
	More winter precipitation falling as rain instead of snow
	Less summer rain
	More frequent and severe droughts
Wind & Storms	More gales and extreme wind events
	More frequent and severe storm events (snow, hail, dust and lightning)
	Increase in hurricanes
	Increase in tornadoes

Soil & Slopes	Increased site runoff
	Decreased slope stability
Seismic	Potential for shallow fault, subduction zone and deep earthquakes
Other	Pandemic, air-borne disease vectors, infectious agents

Determining Likelihood

1) Consider the likelihood that an event will occur in the 2020s as a discrete and/or ongoing event.

- Use a scale with criteria to assign a likelihood rating (see Table 7 for an example).
- Where key information is lacking, review the criteria for discrete and ongoing events with the support of a climate scientist or other subject matter expert (e.g. hydrologist).

Table 7: *Likelihood rating scale for discrete and ongoing climate-related events (Source: Climate Action Secretariat).*

Likelihood*	Rating	Criteria For Discrete Climate-Related Risk Events	Criteria For Ongoing Climate-Related Risk Events
Almost certain	5	Event is expected to happen about once every two years or more frequently (i.e. annual chance ≥ 50%*).	Event is almost certain to cross critical threshold.
Likely	4	Event is expected to happen about once every 3 to 10 years (i.e. 10% ≤ annual chance < 50%).	Event is expected to cross critical threshold. It would be surprising if this did not happen.
Possible	3	Event is expected to happen about once every 11 to 50 years (i.e. 2% ≤ annual chance < 10%).	Event is just as likely to cross critical threshold as not.
Unlikely	2	Event is expected to happen about once every 51 to 100 years (i.e. 1% ≤ annual chance < 2%).	Event is not anticipated to cross critical threshold.
Almost certain not to happen	1	Event is expected to happen less than once every 100 years (i.e. annual chance < 1%).	Event is almost certain to not cross critical threshold.
***Annual chance is the probability that an event will occur in a given year**			

2) Consider changes in exposure type and magnitude to facility half-life and end-life (e.g. 2050s and 2080s, respectively, for a facility with a 60-year service life). Table 8 provides an example of how hazard trends can be established.

3) Systems and components that are unlikely to be replaced, such as building envelopes, are designed to facility end-life. As building systems and facilities often have service lives extended through retrofits, upgrades and additions, it is prudent to expand the time horizon as per professional judgment.

Table 8: Hazard trends for facility opening day, half life and end life.

Hazard	2020	2050	2080	Trend
Warmer summer temperatures	4	5	5	Increasing
Increased frequency and severity of wildfires	3	4	4	Increasing
Sea level rise	1	4	5	Dramatically increasing
More frequent and intense precipitation	1	4	5	Dramatically increasing
More gales and extreme wind events	4	4	4	Steady

Prioritizing Hazards

The outcomes of the Screening should be clearly summarized to allow for clear communications throughout the project, as shown in Table 9 below.

Table 9: Example of prioritized hazards for a facility.

Relevant Hazards & Priority Levels					
High	Extreme heat	Wildfires	Pandemic		
Medium	Droughts	Riverine flooding	Severe storms and high winds	Earthquakes	Decreased slope stability
Low	Sea level rise	Hurricanes	Tornados	Tsunami	

Addressing Data and Information Gaps

1) Consult the list of data and information gaps noted in previous steps to determine if supplementary technical study and analysis are required to develop project design options and costing.
    - Where publicly-available information or an evidence-based consensus do not yet exist (e.g. wind, humidity), integrate measures to address information gaps into the technical studies carried out to prepare the Concept Plan and Business Plan.
    - Alternatively, commission additional studies for the service area as a cost-effective measure to support decision-making for multiple sites and facilities.
2) Integrate the work required into technical study scopes, and into consultant RFP and submission evaluations. Carry out technical studies that must be completed prior to Indicative Design Team and Preliminary Climate Risk Assessment (see Section 6.1).
3) For community-level issues where a broader discussion with subject matter or industry experts is likely useful to surface information and insights (e.g. roundtable), identify current and emerging best practices (e.g. guidance from practitioners); and, identify potential longer-term research (e.g. requiring substantial funding, partnerships with academic institutions, health researchers or non-government organizations). For example:
    - Flood hazard risk analysis for critical supply chains and infrastructure;
    - Grey/green infrastructure integration analysis for on-site surface water retention, filtration and slow-release (by landscape architects, structural engineers); and
    - Ground-level ambient air temperature readings during warm summer periods (by academic researchers in partnership with local governments).

6.2. STEP 2: Preliminary Climate Risk Assessment

What is the Preliminary Climate Risk Assessment?

The intent of the Preliminary Risk Assessment is to provide a nuanced and fulsome understanding of climate risks to people, assets and infrastructure, health services at the site and off-site (i.e. community) levels. It will inform the development of Base and Enhanced Design Options for the Business Plan. After Business Plan approval, it will also inform the development of design and construction specifications for the market.

More broadly, results and recommendations are shared with key partners and collaborators in both the public and private sector to further reduce risks to health facilities and services.

When should the Preliminary Climate Risk Assessment happen?

The Health Authority should begin preparing for the Preliminary Climate Risk Assessment upon approval of the Concept Plan to ensure sufficient time and resources for completing key steps prior to the workshop.

The preliminary assessment must be carried out in a workshop that is held during the initial stage of Business Plan development (i.e. immediately after completion of the Indicative Design Team's Project orientation). This will ensure that results inform subsequent activities including development of design options and costing.

Responsibilities

The Health Authority and Indicative Design Team are responsible for the Preliminary Climate Risk Assessment. The assessment methodology and expected outputs will also be reviewed with the Health Authority to ensure consistency, viability and alignment with needs and expectations for the people, assets and infrastructure, health services.

The Indicative Design Team's climate risk assessment expert is responsible for designing and facilitating the Preliminary Climate Risk Assessment Workshop.

Expected Results & Outputs

The Preliminary Climate Risk Assessment (described in this section) will result in validated resilient design objectives that are included in the Business Plan, resilient design strategies and implementation pathways that can be incorporated into the Base and Enhanced Design Options, Class C capital cost estimates, and an Indicative Design that sets a resilience baseline for Designers and Builders in subsequent steps.

Outputs include:

- ✓ A summary of resilient design objectives, strategies and implementation pathways with cost estimates
- ✓ Design brief recommendations by the Indicative Design Team
- ✓ Design and Construction specifications by the Compliance Team
- ✓ Resilience baseline for schematic design and design development
- ✓ Off-site information for integration into the High Level Master Plan
- ✓ On-site and building systems information are integrated into Site Plans (e.g. Clinical and Infrastructure Plans)

Additionally, results will provide a basis for more accurately and comprehensively calculating capital and operational costs to facility end life, and the basis for informed decision-making beyond the scope of a single project, organization or jurisdiction; ongoing discussions with interdependent critical infrastructure owners and operators; and, baseline information for multi-agency response and preparedness for extreme events (e.g. cooling and clean air shelters).

By sharing information and recommendations with key partners and collaborators in both the public and private sector, the Health Authorities can further reduce risks to health facilities and services.

Key Steps & Information

Key steps are organized into three sub-sections to help ensure that complete information sets are available to workshop organizers, workshop participants, and the project: **Pre-Workshop**, **Workshop**, **Post-Workshop**. Health Authority experience to date indicates that a minimum of six weeks is required to prepare for the workshop including: identify and prime workshop invitees; assemble and develop workshop resources and materials; and, refine and test methodology including delivery platform (e.g. online).

The workshop should be carried out in one full-day session (or two successive half-day sessions) to preserve flow and momentum, with frequent short breaks (e.g. 10 minutes). Workshop outputs must be completed in time for the Indicative Design Team to develop design briefs that inform the Base and Enhanced Design Options, and for the cost consultant to complete Class C estimates.

A. Pre-Workshop

A1. Indicative Design Team Prime Consultant

1) Review key information with the Design Team:
    - Climate Hazard Exposure Screen outputs and recommendations
    - Supplementary technical study outputs (e.g. flood risk analysis)
    - Municipal plans, policies, regulatory obligations (e.g. on-site rainfall capture) and bylaws that are relevant to the climate hazards identified (e.g. hazard development permit areas)
2) Direct the team to identify and address key information gaps, for example by:
    - Consulting hazard resources, and subject matter experts
    - Conducting high-level technical study, scenario analysis or modelling
3) Facilitate Design Team input into the preliminary assessment process by:
    - Preparing an inventory of design strategies that may inherently increase resilience (e.g. existing Health Authority or municipality requirements)
    - Reviewing resilient design best practices, and the Health Authority's cost consultant estimates, in peer jurisdictions

A2. Health Authority Staff, Advisors & Consultants

1) Prepare for the Workshop by:
    - Identifying and engaging key stakeholders as potential workshop invitees (see example in Table 10). Project User Groups and key stakeholders (e.g. as per Site and Facility Plans) are priority workshop invitees and/or focus group members to inform workshop planning and execution.
    - Seeking a well-balanced representation for the people, assets and infrastructure, health services.

__Table 10:__ Suggested workshop invitees.

Key Stakeholders
Project
• Prime Consultant / Architect • Mechanical, Electrical, Structural and Civil Engineers • LEED / Sustainability • Energy and Emissions / Energy Modeling • Landscape Architect • Clinical Planning and Operations • Facility Maintenance and Operations • Clinical Operations (e.g. physicians, nurses) • Kitchen / Food / Laundry Service
Service Delivery Area & Health System
• Local and regional government departments (e.g. engineering, sustainability, planning and development, parks, permitting) • Power utilities (electricity, district energy, microgrid providers) • Water and sewerage utilities • Virtual Health • Information Management / Information Technology (IMIT) • Infection Prevention and Control (IPC) • Population & Public Health / Environmental Health Officers • Health Emergency Management BC (HEMBC) • BC Center for Disease Control (BC CDC) • Allied Health, and Support Services • PHSA Supply Chain • Business Support Services (BISS) • Public Transit / Transportation / Traffic

- Developing a workshop primer that enables invitees to engage with a sense of agency (i.e. action is in the near-term is plausible), and includes an overview of:

    a. Workshop purpose and process (e.g. agenda, participants, expected outcomes)

    b. Climate hazard projections, and examples of past impacts

    c. Cascading impacts on service delivery, staff and patients

    d. 'Pre-homework', if appropriate. For example, reflecting on recent experiences with climate shocks and stresses in the workplace; checking in with peers and colleagues on significant disruptions; and, reviewing workplace health surveys, incident reports and other internal resources. A short pre-survey also is an opportunity to establish a dialogue with invitees, identify potential workplace champions, and better understand the perspectives of particular disciplines or workgroups.

- Assembling and developing key workshop materials (and identifying what needs to be developed by facilitator) that includes:

    a. Climate projections for hazards

    b. Climate Hazard Exposure Screen (see Section 6.1) and technical study outputs

    c. Climate scenarios that reflect the project context

    d. Vulnerability criteria and scale

    e. Consequence criteria and scale

2) Work with the Project Team to ensure that the Indicative Design Team RFP includes:

- o Prime Consultant experience in integrating climate hazard information and analysis into development of design options, implementation pathways and costs (with the QS);
- o Sub-consultants with core competencies in utilizing climate Projections data to factor in current and future climate conditions into design (e.g. establish design conditions)
- o A workshop facilitator with climate risk assessment experience

3) Provide key information to the Design Team, and indicate information gaps to be addressed by the team.

- o It is important to note is all the work required for this step will be completed before the Workshop. The Indicative Design Team should identify appropriate members to do more in-depth analyses (e.g. acquiring more granular datasets to inform site-specific likelihoods for hazards).

4) Confer with the workshop facilitator to:

- o Review the workshop primer sent to workshop invitees;
- o Confirm the scope of the assessment;
- o Review the confirmed invitee list, and agree on breakout groups with balanced representation;
- o Validate or develop key workshop materials including vulnerability and consequence criteria;
- o Identify tools or processes to be developed or adapted for an online or in-person workshop format (e.g. a spreadsheet or whiteboard tool to manage participant input in real-time, or to record proceedings);
- o Consider a separate communication channel to enable communication among facilitators and Health Authority (e.g. a mobile chat group);
- o Agree on the preliminary assessment methodology proposed by the facilitator, noting successes and lessons learned from previous assessments and best practices;
- o Test the methodology in advance of the workshop to review activities, uncover gaps in the process, and address any anticipated challenges;
- o Send a reminder to confirmed invitees (and follow up to the original invitation and primer) with:
    a. A workshop agenda, time and location, and expected outputs;
    b. Climate scenario descriptions for pre-assigned breakout group;
    c. Vulnerability scale (with ranking criteria), likelihood scale (with ranking criteria) and consequence (with consequence criteria) scale; and
    d. A glossary of key terms, and link to resources for further information

B. Workshop

B1. Provide Context

- Identify and map workshop participants in terms of people, assets and infrastructure, health services. Roundtable introductions may start with those representing the project, and expand outwards (in terms of sphere of influence) to the service delivery area and health system. Invite participants to share a story, fact or resource that gives a high-level understanding of their particular perspective.
- To understand the implications of climate change on a health facility, it is important for participants to understand the setting and role of the facility within its community in the near-term and into the future. The

Climate Hazard Exposure Screening (see Section 6.1) and supplementary technical studies described above will have started to establish the physical hazard context for the project. Consider including a Q&A session with a climate scientist or other technical experts (e.g. hydrologist) to help understand conventional concepts and practices (e.g. uncertainty, likelihood) in the context of climate change (e.g. compounding hazards). Participants also may appreciate having direct access to subject matter experts.

- Review the policy and legal context for the project, including municipal plans, policies, bylaws that intersect with climate change resilience, and details of the project, including different phases.
- Present key information, inventory of design strategies (that may inherently increase resilience as required by the Health Authority or by the municipality such as hazard development permit areas), and examples of best practices (Indicative Design Team).

B2. Identify Hazard Impacts

With context established, the next step is to generate clear and concise impact statements.

Statements identify the climate-related shock or stress (e.g. prolonged heavy rainfall, increased frequency of heat waves) and the impact on the facility or service (e.g. inability to access facility due to overland flooding, increase in staff shortages (see Box 2 for examples). Value-based judgement is a necessary part of developing impact statements, as the process is inherently subjective and impacts are often dynamic. If discussions on risk thresholds emerge (e.g. the point at which strains or failures result in unacceptable levels of reduced quality of care), note this information for later work on the consequence scale. To develop impact statements, complete the following steps:

- Ask workshop participants to reflect on actual experiences in the workplace within the last 3-5 years. Recall recent extreme events and impacts with images (e.g. 2018 BC wildfires, 2019 global heat wave, or 2020 Ontario flood evacuation centers with physical distancing measures), media reports, or statistics (e.g. number of increased hospital admissions, percentage increase in medication dispensation for non-asthmatics).

Box 2: *Examples of Impacts on People, Assets & Infrastructure, and Health Services*

Criteria	Climate Hazards				
	Heat	Wildfire Smoke / Poor Air Quality	Flooding	Wind	Chronic Stresses
People *patients, clinicians, facility staff*	• Missed work days, increased overtime, and staff retention difficulties • Increase number of ED visits due to respiratory problems	• Decreased ability to discharge patients due to oxygen needs • Higher number of staff absences	• Decreased ability to access the site • Increased infection and mold risk in building materials • Losses and damages increase mental health issues	• Power outages impact ability of care deliver for complex patients *(patients)* • Stress to facility staff due to power and system outages	• Drought decreases water available for drinking, bathing, and washing • Increasing temperatures will exacerbate some existing health conditions
Assets & Infrastructure *envelope, equipment, information & communications technology, water supply & sanitation, power supply*	• Overheating causes operation mechanisms of sliding glass doors to seize; other building components see decreases service life	• Redundancy and sufficient resources only allow systems to handle catastrophes for short duration (<72 hours) • Increase in air contaminants infiltrate through building envelope, impacts HVAC system ability to maintain adequate IAQ	• Reduction in water quality; compromise in process water (e.g. sanitizers, sterilization)	• Power outages cause facilities to run on generator power, burning excessive fuel • Higher loads on building envelope, leading to premature degradation; hazards from flying objects and debris	• Water shortage affects sterilization and sanitation • Backup cooling water, cooling towers, and boilers affected by water shortage
Health Services *virtual health, tele-health, pharmacy, laboratory & testing, home care*	• Failure of IT systems due to operating at temperatures above design thresholds • Lab results lost or deemed inaccurate due to higher temperature in Lab Equipment Room	• Power impacts due to forest fires near power lines, loss of power and impact to virtual communication • Poor air quality in homes; patients may need to visit hospital if homes have poor ventilation and filtration	• Reduced movement of goods and people (e.g. pharmaceutical supply impacts) • Increase in health service demands due to overall reduced community health	• Disruption to transportation and community health care, resulting in increasing hospital visits • Home health inaccessible due to loss of phone and internet access	• Lack of water supply can increase likelihood of contamination of instruments and equipment

- Structure statements using a clear formula: hazard, primary impact (and cascading impact). For example:
  - Building: Variability in winter temperatures may increase the need for chillers year-round (and increase operational costs).
  - Site: Hotter temperatures may cause increased hospital visits for new and chronic health conditions (and stretch availability of services).
  - Off-site: Strong wind events may disrupt utility and transportation networks (and challenge hospital resupply).
- Categorize statements into people, assets and infrastructure, health services.
- Refine impacts statements by removing redundancies and overlaps, and editing for clarity and consistency.
- Select statements that advance to the next exercise.

In the event that time is short, it may be expedient to use a “quick start” tool in initial discussions with a small group of project stakeholders to establish the need for further action (see Box 3).

Box 3: *The Climate Change Extreme Event Screening Tool for Projects*

This “quick start” tool, developed by Island Health, can be used to identify hazard impacts and determine next steps.

Climate Change Extreme Event Screening Tool for Projects

Project Name:

Project Location:

Service Life of Project:

Date:

Participants:

Department: Sustainability, Energy Management, Facilities

Intended Project Outcomes:

Climate Variable(s)	Climate Impacts	1. Has the climate impact occurred in the recent PAST at the facility?	2. Will this climate impact negatively affect the intended outcomes of the project at completion?	3. As the climate impact intensifies will there be negative effects to the intended outcomes of the project over its service life?	4. Is there an opportunity to include other enhancements to build resilience within this project or in future projects?
1. Warming	Overheating				
2. Increased / Reduced Rainfall	Reduced water quality (eg. turbidity, temperature, total dissolved solids)				
3. Reduced Rainfall	Water shortage				

In this step, it is recommended that the organizers include **future climate scenarios** for hazards of concern, to describe situations in which it would be difficult for the health facility to maintain its essential functions based on climate-related shocks and stresses. By grounding thinking in the future, this exercise can encourage participants to generate and refine impacts for the facility, and to explore tipping points and cascading impacts that may be experienced.

Scenarios include variables that Design Teams need to consider (e.g. hottest day, cooling degree days) and frontline staff can relate to with respect to patient impacts (e.g. days above 30°C, nights above 20°C). Scenarios are not, however, intended to present a particular set of conditions that need to be designed for. These 'stress tests' can help participants to:

- Make a link to future climate hazards that people can relate to. While it is not necessary to include all climate hazards, it is important to ensure alignment with future projections.
- Use the power of story to bring together diverse perspectives and experiences across the health system.
- Better understand vulnerability and risks (i.e. how do we define what is at risk, and what are our risk tolerance thresholds).
- Explore broader concepts including compounding hazards, cascading impacts and critical infrastructure interdependencies.

B3. Explore Sensitivity & Adaptive Capacity

Sensitivity is the extent that a change, whether positive or negative, affects health and well-being or function.

Adaptive capacity is the ability to adjust to change. It also may be expressed in terms of level of effort required to adjust. For communities of care, it varies across hazards and is subject to factors such as access to health services, employment and working conditions, physical environment (e.g. housing), social supports and coping skills, existence of hazard response plans[13].

Reducing sensitivity and increasing adaptive capacity to climate shocks and stresses may lessen impacts on Projects, health service delivery areas and the health system. Sensitivity and adaptive capacity may change with circumstance (e.g. coronavirus pandemic) and over time (e.g. as the likelihood of extreme wildfires increase).

To explore the sensitivity of the people, assets and infrastructure, health services to the impacts identified, and determine the level of capacity (or effort) to reduce impacts identified, work in breakout groups to:

1) Review the pre-assigned climate scenario. Where scenarios are unclear, refer to climate hazard Projections or subject matter experts.
2) Review the vulnerability criteria provided, and note participants' reflections for future reference.
3) For each refined impact statement, ask:
    - "If the impact occurs, to what extent will health and safety (people), functionality (assets and infrastructure), and ability to deliver timely and high quality health services be negatively affected"? Rank sensitivity on a scale of 1-5 (i.e. 1=low, 5=high).
    - "How much time, effort and cost are needed to cope with the impact"? Rank adaptive capacity on a scale of 1-5 (i.e. 1=low, 5=high).
4) Multiply the sensitivity and adaptive capacity scores for a total score for each impact statement. Review and confirm the scores with the breakout group.

[13] HealthADAPT, 2020

5) Take forward **all scored impact statements** to the next step. Keep in mind that low vulnerability score items may become high risks later in the facility lifecycle as exposure, sensitivity and adaptive capacity change with time and circumstance.

The service life of major assets and infrastructure is important to consider. The building envelope for example is unlikely to be replaced due to the expense. Questions to ask include: What is required to accommodate upgrades to chiller plants that are suitable for peak cooling conditions in 20 years (e.g. components, connections, physical space)? What are the cascading impacts on e.g. chilled water piping, air handling unit cooling coils, perimeter air supply volumes, future electrical load of added impact (including on generators)?

In this step, the impacts from above should be prioritized in order to focus project resources on the areas of greatest need. This can be achieved by considering:

- The **likelihood** of occurrence based on the expected return period or probability of the hazard event or trend occurring at the facility.
    a. Participants rank likelihood based on the Climate Hazard Exposure Screening (see Section 6.1) outputs, past experience and events, and the probability of their occurrence in the future given climate change Projections.
    b. Participants use knowledge of past events, expert judgement, professional experience and available information to score.
- The **consequence** of that impact should it occur, based on the severity of the consequence to people, assets and infrastructure, and health services.
    a. Depending on the approach used, consequence can be rated over numerous categories to capture the range of effects that climate change can have. The consequence scale in Table 11 may be used as a starting point.
    b. Consequence can be considered as an average across categories, or can be purposely weighed so that an impact with catastrophic consequences will be carried forward regardless of its average (e.g. a power outage may not damage the site or facility, but would have severe or catastrophic consequences across other categories).

Take forward all impact statements ranked as '4 Major' and '5 Catastrophic'.

Here, it is also valuable to discuss levels of risk that are deemed acceptable (i.e. risk thresholds), based on a dialogue with stakeholders and a careful documentation of their perception of the risks. The results may warrant increased budget, scope and / or schedule.

B4. Evaluate Climate Risks

The outcomes of the above exercise will be used to assign a total risk score for each impact, which can help to inform prioritization and decide as to which impacts to focus on for resilience planning. Organizations may choose to use their own relative risk scale, but generally impacts will be categorized as:

- **Low:** These impacts are the least urgent. Implementation of resilience strategies in the redevelopment project will enhance preparedness.
- **Medium:** These impacts may reduce the viability of the facility. They should be addressed through the project wherever it is feasible to do so.
- **High:** These impacts are of the greatest concern to the facility. Corrective measures should be included in the redevelopment project to reduce risk to an acceptable level

Regardless of the outcomes of the above, stakeholders should be given a final opportunity to review and elevate impacts ranked as even low-risk to the strategy planning stage if it is line with organizational priorities.

Table 11: *Example of a consequence scale, adapted from BC Preliminary Strategic Climate Risk Assessment (Climate Action Secretariat, 2019).*

Criteria	Consequence Scale					
	No Risk 0	Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Psychological impacts on patients and staff	No psychological impacts on patients and staff	Minimal expected reactions of fear, anxiety, or disruption to daily routine	Localized moderate disturbance resulting in temporary psychological impacts (e.g. feelings of fear and anxiety)	Widespread moderate disturbance resulting in temporary psychological impacts (e.g. feelings of fear and anxiety)	Localized severe disturbance resulting in long-term psychological impacts (e.g. loss of identity, or sense of place)	Widespread and severe disturbance resulting in long-term psychological impacts (e.g. PTSD)
Patients and staff safety	Patients and staff safety will not be impacted	No intervention or treatment required	Isolated event. One individual impacted. Minor harm requiring first aid or minor intervention	Moderate harm, requiring medical treatment, small number of individuals impacted	Major harm, leading to long term incapacity or disability. Several individuals impacted	Death or major harm, leading to permanent incapacity. Large numbers of individuals impacted.
Health service delivery	Consequences will have no impact on health service delivery	Consequences will be dealt with by routine operations	Consequences would threaten the efficiency or effectiveness of some services, but would be dealt with internally	Consequences would require significant review or changed ways of operating	Consequences would threaten continued effective provision of services and require top-level management intervention	Consequences would threaten provision of key services causing major problems for patients, clients, and staff.
Hospital assets	No hospital assets are at risk	Little disruption of non-critical hospital assets	Minor short-term impacts(mainly reversible) on hospital assets	Considerable impact upon access to hospital assets	Extensive damage to hospital assets with wide-spread impacts	Hospital assets are completely damaged with irreversible loss
Monetary loss	No monetary loss	<$10K	$10K-$250K	$250K-$1M	$1M-$10M	>$10M

B5. Develop Resilient Design Strategies & Implementation Pathways

As per the overarching principles of the Resilience Guidelines, strategies and implementation pathways should:

- Consider multiple levels or scales concurrently
- Anticipate interruptions and change
- Allow for iteration and continuous improvement
- Emphasize ‘no-regrets’ options and implementation pathways
- Prioritize simple, flexible and durable design strategies
- Cultivate synergies between strategies

C. Post-Workshop

C1. Workshop facilitator

- Prepare a workshop report within two weeks with an analysis of hazards and compounding hazards, primary and cascading impacts, vulnerability and risks. The analysis and recommended actions to reduce climate risks and embed resilience in Design and Operations are categorized by:
- Key exposure categories: people, assets and infrastructure, and health services to facilitate the identification of key roles and responsibilities at the department (or business unit) level;
- Assets and infrastructure are sub-categorized at the building system, site and off-site scales to facilitate development of requirements;
- Design or operations;
- Viability such as ‘easy wins’ and/or ‘low hanging fruit’, ‘further consideration is warranted’, and ‘prohibitive’ (e.g. cost, technical); and
- Level of innovation (e.g. standard in BC *Building Code*, low carbon and resilient to 2050 with flexibility to 2080, or low carbon and resilient to 2080.

C2. Indicative Design Team

- Review the workshop report results, in particular all impact statements ranked as major and catastrophic, to inform development of design options and implementation pathways.
- Coordinate and integrate all consultant and external advisors input and outputs into development of design options and costing:
- Arrange by priority or in a hierarchy (e.g. passive first)
- Describe in relation to other key design strategies (e.g. envelope and HVAC)
- Submit a summary of resilient design objectives, strategies and pathways; cost estimates, included in the Indicative Design; and, an overview of the selection and prioritisation process to the Health Authority

C3. Health Authority

- Evaluate the workshop report and recommendations to ensure alignment with intent.
- Review sub-consultant design briefs and summary of resilient design strategies to understand how assessment results are factored into design options and costings

6.3. STEP 3: Climate Risk Assessment Workshop

What is the Climate Risk Assessment Workshop?

The Climate Risk Assessment Workshop provides Proponents with an opportunity to validate the results and outputs from the Health Authority’s Climate Hazard Exposure Screen (see Section 6.1) and the Preliminary Climate Risk Assessment (see Section 6.2); assess climate risks with respect to their particular design options; and, identify any material information gaps or questions. The workshop also provides the Health Authority with an opportunity to ensure that the intent of the requirements and incentives, and the importance of climate resilience, is conveyed clearly to Proponents.

The intent of this step is to support Proponents in identifying and reducing climate risks, and to encourage innovation in achieving low carbon resilience, at the most efficient and cost-effective junctures in schematic design. As such, it provides value for the time and effort expended in terms of e.g. identifying designs that may be inherently resilient, or factors that compel resilient design (e.g. local regulations); ensuring that opportunities to embed resilience are not missed, especially where uncertainty is a significant factor (e.g. pandemic);

validating good measures and flagging ineffective solutions early in the design process (30%); and, improving a shared body of knowledge for the current and subsequent projects.

As such, the assessment workshop should focus on Proponents' proposed designs, indicate significant deviations from indicative design, and verify how compliance is achieved. Proponents will have the opportunity to present equal-or-better solutions to the requirements, which is intended to encourage industry innovation and bring progressive resilience strategies to the forefront.

It is important that this process is managed such that Proponents have ownership of and accountability for the proposed strategies (e.g. a formal post-workshop report with feedback and recommendations from the Health Authority, contract amendments associated with the workshop outcomes), and it does not place undue burden on any party.

When should the Climate Risk Assessment happen?

The Climate Risk Assessment Workshop should be conducted during the Request for Proposal phase by qualified proponents bidding on the project, as required in the project tender and requirements. It should occur before the Detailed Design phase, where the Successful Proponent will demonstrate compliance and verify that the design sufficiently addresses climate risks and resilience requirements.

Responsibilities

Each proponent is responsible for carrying out a workshop with support from experienced Climate Risk Assessment professionals and guidance from the Health Authority at the 30% design stage. Where there are multiple proponents, the Health Authority will provide identical baseline information and responses to requests for information to all proponents to ensure transparency and fairness. The Workshop should ideally be carried out in a formal session such as a Special Topic Meeting.

Where key stakeholder engagement (or re-engagement) be required, the Health Authority will arrange for input (e.g. during Collaborative Meetings or additional Special Topic Meetings). Input also may be provided in Requests for Information (RFI) to the Authority.

Expected Results & Outputs

Proponents will be required to submit a draft report to the Health Authority for review within three weeks of the workshop. Feedback may be addressed in a Special Topic or Collaborative Meeting with the Proponent, or in response to a Request for Information. The final report will be included as part of the Proponent's Technical Submission, along with compliance measures. The report must:

- ✓ Demonstrate through design how proponent has responded;
- ✓ Show how design considerations address medium-high and high risks at opening day, half life, end life;
- ✓ Document residual risk and third-party supplier risks;
- ✓ Describe assumptions, including risk thresholds; and
- ✓ Develop climate risk brief for review with the local government and Panel.

Key Steps & Information

Health Authority experience to date indicates that a full-day workshop with proponents and the compliance team is necessary to understanding and reducing risks, and is beneficial for all parties involved. Moreover, cascading benefits in terms of increased knowledge and competency is observed among workshop participants.

The Climate Risk Assessment Workshop comprises a workshop carried out in two parts to validate and add to the results of the Preliminary Climate Risk Assessment (see Section 6.2) from a constructability perspective. The Health Authority, Compliance Team and Proponents are required to collaborate to ensure viability from the Owner and Builder perspectives.

The workshop may integrate components of other methodologies (e.g. fault tree analysis, PIEVC Protocol analysis) to test whether a set of strategies and pathways is likely to achieve resilient design objectives (e.g. maintain thermal comfort in an extended heatwave), co-benefits (e.g. occupant health) and synergies (e.g. seismic resilience).

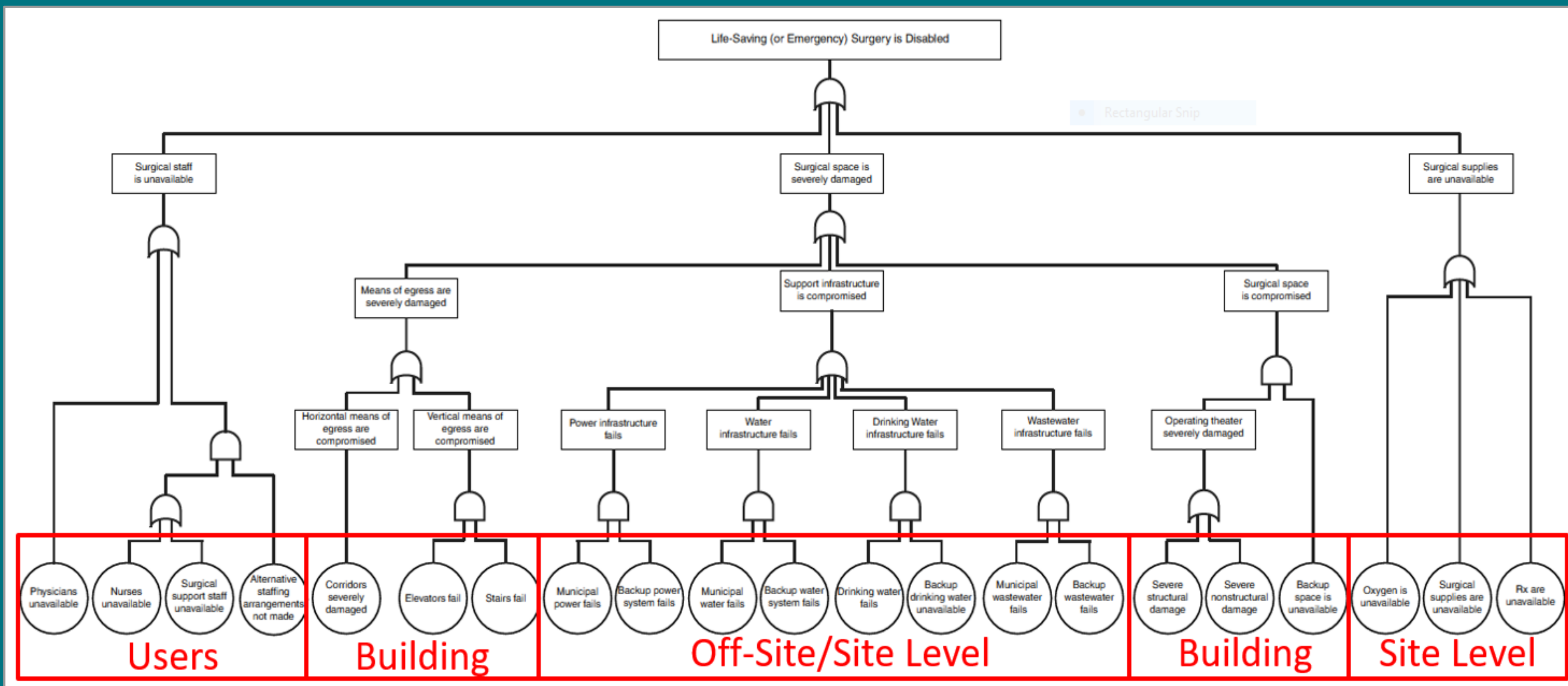
See *Box 4* for an example of how a fault-tree analysis[14] can be used to better understand impacts on people ('users'), assets and infrastructure at the building, site and off-site levels.

[14] Megan Boston, University of Waikato. (2018). *Resilience by Design: Improving Hospital Functionality Following Earthquake.*

Box 4: *Linking the fault-tree analysis for seismic risk to the climate risk impact assessment framework with loss of function of life-saving (or emergency) surgery (Source: Dr. Carlos Molina-Hutt, UBC Engineering for Seismic Risk Laboratory).*

This fault-tree analysis may be used to[1]:

- In scenarios to predict loss-of-service to one or more hospital services given a set of damage.
- In probabilistic assessments of building performance following a performance-based design analysis.
- For rapid real time analysis of a hospital's current state of operability following an event.
- To inform decisions on placement of critical equipment, hospital services, and general hospital layout to improve services the hospital can render following an earthquake.



Workshop Part A

Workshops should be designed and delivered by experienced facilitators hired by the Proponents, with reference to key information and resources provided by the Health Authority. At the workshop start, the Health Authority and Compliance Team should review key information with the proponents to set the context. Key steps include the following:

1) **Review hazards, impacts and risks:** The Health Authority should review the key outputs from Climate Hazard Exposure Review, supplementary technical studies, and Preliminary Climate Risk Assessment. Proponents must identify any information gaps or questions for the Health Authority and Compliance Team, for example:
    - Are the identified hazards relevant and applicable? What hazards are missing, and what data and analysis is required to understand maximum values (extremes), and the magnitude, likelihood, frequency, and duration of extreme events?
    - Are data sources up to date? What other data is available to support further analysis?
    - Can proponents dive deeper with further technical studies to fill gaps?
    - Has anything been overlooked?
2) **Review resilient design strategies, implementation pathways and project requirements:** The Compliance team should review the Preliminary Climate Assessment (see Section 6.2) outputs, project requirements and compliance measures with the proponents to:
    - Confirm the requirements that they must meet in accordance with the Requirements, along with any resilience requirements from the local government.
    - Ensure that the intent of the requirements is clear to proponents, and convey the importance of climate resilience to the Health Authority.
    - Address any information gaps or questions about the requirements and compliance measures.
3) **Improve and generate further resilient design strategies:** Based on the above information, workshop participants will work collaboratively to brainstorm further ideas to strengthen existing resilient design strategies, as well generate new strategies to fill in any identified gaps. In this process, participants are guided to consider resilience strategies that can be feasibly implemented and that:
    - Help reduce risk and build overall capacity;
    - Align with efforts to mitigate climate change (i.e. low-carbon resilience);
    - Support seismic resilience;
    - Support pandemic resilience; and
    - Integrate with other goals and values of the facility and organization (i.e. co-benefits).
    - In addition to the expertise in the room, strategy development can be further supported through the suggested best practices included in Section 8 of this document.
4) **Validate design strategies, implementation pathways and underlying assumptions:** As the final step in the Workshop Part A process, participants will conduct a high-level evaluation of generated strategies to highlight those strategies most worth pursuing. The method of evaluation will vary depending on organizational priorities. Consider using the criteria applied in the Preliminary Climate Risk Assessment (see Section 6.2) to evaluate strategies for:
    - Effectiveness in fulfilling the requirements and enhancing resilience;
    - Effort and/or resources required;

- Costs (both operating and capital) and return on investment;
- Synergies and co-benefits with other organizational priorities; and
- risk threshold (noting that not all measures require same level of treatment and effort).

Workshop Part B

In Part B, proponents present their design (30%) with key design strategies and implementation pathways. Proponents demonstrate that outputs are factored into 30% design with a presentation supported by pre-development site plans, building schematics, site plans with narratives and indications on drawings:

- Identify any strategies already planned for the design that may inherently enhance resilience (i.e. carried forward from the Indicative Design);
- Review any strategies that have been added by the Proponent, including those informed by additional studies carried out by the Proponent;
- Flag synergies (e.g. emissions reduction, seismic, pandemic) and potential redundancies (intended and unnecessary);
- Provide a fulsome explanation of any equal-or-better alternatives to the project requirements, and implications for compliance measures;
- In the workshop environment, the above should be captured in a presentation by the Design Team that informs stakeholder engagement.

Proponents must address the following questions:

- What are the relevant requirements for reducing climate risks for mechanical, electrical and structural?
- What measures are already in place? (e.g. flood construction level, architectural details)
- What are the hazard-specific resilience features of the current design at 30%, and the underlying assumptions?
- How do the implementation pathways allow for the interventions needed to cope with climate impacts over time?
- How much are the design strategies likely to cost over time in conventional (e.g. net present value, payback period) and more holistic (e.g. occupant health) terms?

The Health Authority and Compliance Team will provide feedback on the proposed design strategies and implementation pathways for Proponents to take into account in subsequent design stages.

6.4. STEP 4: Climate Resilience Compliance Audit

What is the Climate Resilience Compliance Audit?

The Climate Resilience Compliance Audit serves to inform how the Successful Proponent's design sufficiently addresses climate risks and Project requirements, and confirm any equal-or-better alternatives. The intent is to establish a collaborative and iterative mechanism for the Successful Proponent, Health Authority, and Compliance Team (or Independent Climate Risk Auditor) to review the evidence base provided by the Successful Proponent and ensure that resilient design objectives are met. The result is sufficient information to determine compliance, rewards or penalties.

When should the Resilience Checklist be prepared?

The Health Authority and Compliance Team will develop the Compliance Audit, while the Successful Project Proponent will complete and review it with the Health Authority and Compliance Team at each submittal stage to ensure that any modified or new resilient design strategies are able to be incorporated.

In the event that a Climate Risk Assessment cannot be carried out (at all or adequately), then the Successful Proponent will be required to carry out a Climate Risk Assessment at 30% design *prior to* completing the Resilience Audit.

Who is responsible for conducting the Climate Risk Assessment Workshop?

The Successful Proponent is responsible for completing the Resilience Audit and submitting it to the Health Authority and Compliance Team for review, revision as needed, and approval at each submittal stage.

Expected Results & Outputs

The Successful Proponent's design must demonstrate or exceed compliance with the output specifications.

The Successful Proponent must demonstrate that it will sufficiently address material climate hazard risks as identified in the Climate Risk Assessments, meet the Project Agreement requirements, and confirm any equal-or-better alternatives with supporting justification and documentation as required.

Key Steps & Information

The Resilience Audit outlines the requirements in the Project Agreement’s Design and Construction schedule, and describes how the Successful Proponent has met those requirements. It will also include any and all supporting documentation needed for each requirement, as laid out in the Compliance Measures column.

In addition, the Resilience Audit should identify integrated solutions for GHG emissions reductions, seismic resilience and pandemic resilience, as well as highlight future opportunities for synergies with these priorities.

7. RESOURCES

7.1. Overarching Guidance

The following resources provide key information on adapting to climate change, which can inform efforts to enhance health facility resilience in a broad sense:

- Infrastructure Canada *Climate Lens*
- Provincial *Preliminary Strategic Climate Risk Assessment Framework* and the *Hazard, Risk and Vulnerability Assessment* (HRVA) modernization project
- Pacific Climate Impacts Consortium (PCIC) Plan2Adapt tool, Climate Explorer and adjusted weather files
- ClimateData.ca
- Engineers and Geoscientists BC (EGBC) Climate Change Information Portal
- Engineers Canada's *Principles of Climate Adaptation and Mitigation for Engineers*
- Ministry of Transportation and Infrastructure (MoTI) *Resilient Infrastructure Engineering Design Technical Circular T-04/19*

7.2. Resources by Hazard

Key sources of guidance and information for those looking to address specific hazards include:

Warming Temperatures & Extreme Heat

- **For future climate Projections:** Downscaled climate information can help Design Teams to see the specific temperatures that each facility is anticipated to face. This information is available from leading climate authorities, including the Pacific Climate Impacts Consortium (PCIC) data portal and the Federal Climate Data Canada site.
- **For overheating:** BC Housing, in collaboration with the Province, local governments, and utilities, has developed a supplement to the BC Energy Step Code Design Guide that outlines the approaches necessary to reduce the impacts of a warmer climate on residential buildings, with lessons that can apply to health facilities.

Drought

- The Provincial *Drought Response Plan* outlines recommended actions to take before the onset of drought, during the drought, and after drought conditions have subsided. It is supplemented by the Drought Information Portal, which provides drought level updates for each major watershed in the province as conditions warrant. Natural Resources Canada provides further guidance on drought outlooks for different regions, indicators to consider, and adaptation tools and resources

Wildfire Smoke & Indoor Air Quality

- **Wildfire:** The Province provides Wildland Urban Interface (WUI) Risk Class Maps identify wildfire patterns and trends across British Columbia, and include consideration for underlying fuel types, land-based activities and anticipated weather patterns that influence fire behaviour. FireSmart Canada provides a range of leading information on reducing wildfire risk, with the *Protecting Your Community from Wildfire* report outlining numerous lessons that can be applied to health facilities.

- **For wildfire smoke:** The BC Centre for Disease Control (BCCDC) has created fact sheets with information about wildfire smoke and its health impacts, including information on how to prepare for wildfire season. The U.S. Environmental Protection Agency (EPA) also provides helpful information on the impact of wildfire smoke on indoor air quality.
- **For indoor air quality more broadly:** The BC Housing *Design Guide Supplement on Overheating and Air Quality* outlines the key strategies to maintain indoor environmental quality in residential buildings.

Flooding

- **For urban (pluvial) flooding:** Local and regional government documents (e.g. the City of Vancouver's *Integrated Rainwater Management Plan*, and Metro Vancouver's *Template for Integrated Stormwater Management Planning*) can provide locally-downscaled requirements and metrics. The Provincial *Stormwater Planning Guidebook* provides additional information on managing rainfall issues. If urban flooding data is note easily available, the Health Authority should contact the local government for more information.
- **For riverine (fluvial) flooding:** Floodplain maps, including those provided by the Province and by organizations focused on a specific river systems (e.g. Fraser Basin Council), highlight areas that are highly susceptible to flooding. To account for climate change, Design Teams can look to these maps to identify the highest magnitude freshet flood events for present day, 2050 with climate change, and 2100 with climate change.
- **For sea level rise:** The Provincial *Sea Level Rise Adaptation Primer* recommends taking the following numbers into account for sea level rise: 0.5m for 2050, 1m for 2100 and 2m for 2200. Local government documents (e.g. the City of Surrey's *Coastal Flood Adaptation Strategy*) can provide more granular information on areas susceptible to sea level rise and/or storm surge.
- **For tsunamis:** The Provincial tsunami information portal outlines tsunami notification zones, and provides information on what to do before and during a tsunami.

Power Outage

- **For back-up power:** The main guiding document for this topic is CSA Z32 - *Electrical Safety and Essential Electrical Systems in Health Care Facilities*. In addition, the City of Toronto has developed *Minimum Back-up Power Guidelines for MURBs* that discusses opportunities to improve resilience to power outages, with lessons that can apply to health facilities.

Wind & Storms

- **For severe storms and high winds:** The Provincial *Preliminary Strategic Climate Risk Assessment* provides the most up-to-date set of information on storm risk throughout BC. The Plan2Adapt tool offered by the Pacific Climate Impacts Consortium (PCIC) provides further information on community-scale storm risk for present day and into the future.
- **For hurricanes:** The American National Oceanic and Atmospheric Administration (NOAA) offers the most robust set of data on hurricane risk for North America, including historical hurricane landfalls. Note that the occurrence of a major hurricane in British Columbia is highly unlikely. In an account of hurricanes that have occurred in Canada from 1851 to 2016, no Category 4 or 5 hurricane has impacted British Columbia.
- **For tornados:** The Prairie Adaptation Research Collaborative offers leading information on tornado risk in Canada. Note that the occurrence of a significant tornado impact health facilities in British Columbia is

highly unlikely. Although Canada experiences about 80 tornadoes a year, these are mostly focused in the Prairies and Eastern Canada, and Pacific Canada is at little to no risk.

Soil & Slopes

- The Province provides high-level guidance on soil management through the Agricultural Environmental Management Code of Practice, which can serve as a strong foundation for understanding soil issues.
- Local governments often provide more granular information and restrictions, often through development permit areas (DPA) designed to minimize risk and prevent alterations that could cause slope instability (e.g. District of North Vancouver Slope Hazard Development Permit Area).

Seismic Events

- Through its Earthquake Canada portal, Natural Resources Canada provides seismic hazard maps, recent significant earthquake reports and a seismic design tool for engineers based on the *National Building Code*.
- The Province of BC provides more specific earthquake parameters by region through Appendix C of the *BC Building Code*.
- For more site-specific detail, the Institute for Catastrophic Loss Reduction (ICLR) Earthquake Risk Mapping Tool presents relative risk by postal code (considering seismic hazard and population), and some local governments offer modelled scenarios of earthquake risk in the community (e.g. City of Vancouver Magnitude 7.3 Earthquake in the Strait of Georgia).

8. RESILIENT DESIGN STRATEGIES

Throughout the development of the Resilience Guidelines, the Task Force has generated a fulsome list of potential design strategies to increase health facility resilience to climate change. These are based on industry best practices and emerging approaches, and represent the current state of industry knowledge. As such, it should be noted that these are generalized strategies intended to serve as a starting point for discussion. Design Teams are encouraged to push the envelope with innovative strategies and approaches, and to share their findings to help move the industry forward.

The design strategies in this section are linked to the most applicable hazard, and introduced with their likely OPR category, scale, and potential lead team. This is supplemented with a high-level overview of potential synergies and conflicts with other Health Authority goals, including GHG emissions reductions, seismic resilience and pandemic resilience.

8.1. Warming Temperatures & Extreme Heat

Design Strategy	OPR Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Explore opportunities to emphasize role of the facility as a cooling centre and/or community resilience hub.	General Resilience	Off-site	Owner/Operator	Neutral	Positive	Positive
Allow extra space, pipe, coil or ductwork allotment for future mechanical cooling equipment.	Mechanical	Building	Mechanical	Neutral	Neutral	Positive
Carefully consider the tension between over- and under-sizing equipment. Use modular and/or scalable mechanical units for critical equipment, functions or areas.	Mechanical	Building	Mechanical	Neutral	Neutral	Neutral
Ensure that mechanical systems can provide real-time feedback that allow the end user to manually modulate the system.	Mechanical	Building	Mechanical	Neutral	Neutral	Positive
Explore opportunities for thermal storage through a separate heat exchanger, using tanks, earth or groundwater. For example, pull cool air through the ground (i.e. 'earth tubes') via the air handling unit.	Mechanical	Building	Mechanical	Positive	Neutral	Neutral
Increase sewage retention tank capacity for heat recovery storage.	Mechanical	Building	Plumbing	Positive	Neutral	Neutral
Ensure that pipes are easy to access for future upgrades.	Mechanical	Building	Plumbing	Neutral	Positive	Positive
Reserve space adjacent to buildings and across the site for future mechanical equipment.	Mechanical	Site	Architect	Neutral	Neutral	Neutral
Include passive design measures that encourage natural ventilation (e.g. use both high and low windows).	Facility Configuration & Internal Circulation	Building	Architect	Positive	Neutral	Positive
Design for future flexibility during extreme events (e.g. using the parkade for storage of supplies, using the lobby for an influx of patients).	Facility Configuration & Internal Circulation	Building	Architect	Neutral	Positive	Positive
Where appropriate considering future climate conditions, employ thermal mass strategies for passive cooling.	Facility Configuration & Internal Circulation	Building	Architect	Neutral	Neutral	Positive
Include operable windows in strategic locations for back-up cooling and night purge, noting that night purge will become less effective over time as overnight temperatures increase.	Facility Configuration & Internal Circulation	Building	Architect	Positive	Neutral	Positive
Create internal corridors and atriums that are self-shading.	Facility Configuration & Internal Circulation	Building	Architect	Positive	Neutral	Neutral
Orient buildings and open spaces to maximize passive cooling (e.g. layout and form that encourages natural airflow).	Facility Configuration & Internal Circulation	Building	Architect	Neutral	Neutral	Positive
Provide exterior shading (both passive and active), especially for glazing on south and west facades.	Facility Configuration & Internal Circulation	Building	Architect	Positive	Neutral	Neutral
Use high-albedo building materials (e.g. white materials for roofs).	Envelope & Enclosure	Building	Architect	Positive	Neutral	Neutral

Design Strategy	OPR Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Permit high window-to-wall ratios (WWR) only where shown to be critically needed, balancing the need for natural light.	Envelope & Enclosure	Building	Architect	Positive	Neutral	Neutral
Where solar gain and overheating are a concern and have not been addressed with external shading options, use high-efficiency triple-glazed windows with a low solar coefficient to improve thermal comfort.	Envelope & Enclosure	Building	Envelope	Positive	Neutral	Neutral
Use biophilic design to complement cooling strategies and promote positive health outcomes for occupants.	Landscape	Building	Architect	Neutral	Neutral	Neutral
Utilize local, heat- and drought-tolerant planting, and low-pollen trees to optimize shading across the site.	Landscape	Site	Landscape Architect	Negative	Neutral	Neutral
Minimize heat absorbing surfaces in open spaces with low-pollen planting.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral
Provide exterior areas of respite under tree canopy.	Landscape	Site	Landscape Architect	Neutral	Neutral	Positive
Inventory and reduce areas that contribute to the urban heat island effect.	Landscape	Site	Landscape Architect	Positive	Neutral	Neutral
Utilize high-albedo paving on walkways and parking areas.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral
Sell excess waste heat generated on site.	Operations	Off-site	Owner/Operator	Positive	Neutral	Neutral
Capitalize on synergies with the emerging sharing economy.	Operations	Off-site	Owner/Operator	Neutral	Neutral	Neutral
Draft agreements to the local government to establish numerous cooling centres and/or spaces of refuge to prevent facility overload.	Operations	Off-site	Owner/Operator	Neutral	Positive	Positive

8.2. Air Quality Impacts

Design Strategy	OPR Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Use desiccant, oversized chillers to achieve dehumidification under high external humidity conditions.	Mechanical	Building	Mechanical	Neutral	Neutral	Positive
Use enhanced sealing for filters and bypass systems to eliminate gaps that reduce effectiveness. Plan for duct air leakage testing and commissioning.	Mechanical	Building	Mechanical	Neutral	Neutral	Positive
Allocate space both near equipment and elsewhere in the building for storage and stockpiles of enhanced filters (e.g. carbon, MERV 14, HEPA).	Facility Configuration & Internal Circulation	Building	Architect	Neutral	Neutral	Positive
Consider significantly enhanced airflow capability for 'pandemic mode'.	Facility Configuration & Internal Circulation	Building	Mechanical	Neutral	Neutral	Positive
Consider displacement or separate system for outside air ventilation to improve ventilation effectiveness. Intention is to deliver highest quality air close to people and removing contaminants out of breathing zone.	Facility Configuration & Internal Circulation	Building	Mechanical	Positive	Neutral	Positive
Design for colder months by including mechanical ventilation via high-efficiency ERVs to allow higher levels of outside air in peak influenza season. Ensure that system does not contribute to cross-flow contamination.	Facility Configuration & Internal Circulation	Building	Mechanical	Negative	Neutral	Positive
Design for outbreak zones that include 100% outside air, reduced air changes, ultraviolet sanitization and high-performance filtration.	Facility Configuration & Internal Circulation	Building	Mechanical	Negative	Neutral	Positive
Allow for 100% recirculation capacity or 'wildfire mode' that can be employed for short periods of time, which requires that the building is almost leak free and ventilation system has carbon filter capability.	Facility Configuration & Internal Circulation	Building	Mechanical	Negative	Neutral	Positive
Use natural ventilation for extended periods of year (i.e. spring, summer, fall), which is made possible in buildings with high-performance insulation. Provide operable windows in patient rooms, to cut mechanical supply to the room but still allow for room exhaust. Provide a red light/green light system at the window to warn when it should not be opened (e.g. high smoke or wind events).	Facility Configuration & Internal Circulation	Building	Mechanical	Positive	Neutral	Positive
Use non-recirculating air systems where possible with high levels of heat recovery,	Facility Configuration & Internal Circulation	Building	Mechanical	Neutral	Neutral	Positive
Minimize sources of pollutants near air intake locations, including plantings, parking areas, garbage disposal bins, and others.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral
Provide generous outdoor spaces with ample trees and planting to improve local air quality. Consider providing cover in select areas for meetings and meal breaks and to encourage people to use outside spaces.	Landscape	Site	Landscape Architect	Neutral	Neutral	Positive
Focus on low-pollen trees and plantings to minimize allergens.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral
Explore opportunities to clean filters (e.g. roll filters, including grade of prefilters to deal with smoke and pollen particulate).	Operations	Building	Mechanical	Positive	Neutral	Positive
Allocate space for storage of extra personal protective equipment (e.g. masks) to enable expansion of triage efforts.	Operations	Building	Owner/Operator	Neutral	Positive	Positive
Provide space for oxygen tanks and other key supplies in interior refuge areas to help them serve as flexible treatment areas.	Operations	Site	Owner/Operator	Neutral	Neutral	Positive
Use desiccant, oversized chillers to achieve dehumidification under high external humidity conditions.	Mechanical	Building	Mechanical	Neutral	Neutral	Positive
Use enhanced sealing for filters and bypass systems to eliminate gaps that reduce effectiveness. Plan for duct air leakage testing and commissioning.	Mechanical	Building	Mechanical	Neutral	Neutral	Positive

Allocate space both near equipment and elsewhere in the building for storage and stockpiles of enhanced filters (e.g. carbon, MERV 14, HEPA).	Facility Configuration & Internal Circulation	Building	Architect	Neutral	Neutral	Positive
Design Strategy	**OPR Category**	**Scale**	**Lead Team**	**Impact on GHG Emissions Reductions**	**Impact on Seismic Resilience**	**Impact on Pandemic Resilience**
Consider significantly enhanced airflow capability for 'pandemic mode'.	Facility Configuration & Internal Circulation	Building	Mechanical	Neutral	Neutral	Positive
Consider displacement or separate system for outside air ventilation to improve ventilation effectiveness. Intention is to deliver highest quality air close to people and removing contaminants out of breathing zone.	Facility Configuration & Internal Circulation	Building	Mechanical	Positive	Neutral	Positive
Design for colder months by including mechanical ventilation via high-efficiency ERVs to allow higher levels of outside air in peak influenza season. Ensure that system does not contribute to cross-flow contamination.	Facility Configuration & Internal Circulation	Building	Mechanical	Negative	Neutral	Positive
Design for outbreak zones that include 100% outside air, reduced air changes, ultraviolet sanitization and high-performance filtration.	Facility Configuration & Internal Circulation	Building	Mechanical	Negative	Neutral	Positive
Allow for 100% recirculation capacity or 'wildfire mode' that can be employed for short periods of time, which requires that the building is almost leak free and ventilation system has carbon filter capability.	Facility Configuration & Internal Circulation	Building	Mechanical	Negative	Neutral	Positive
Use natural ventilation for extended periods of year (i.e. spring, summer, fall), which is made possible in buildings with high-performance insulation. Provide operable windows in patient rooms, to cut mechanical supply to the room but still allow for room exhaust. Provide a red light/green light system at the window to warn when it should not be opened (e.g. high smoke or wind events).	Facility Configuration & Internal Circulation	Building	Mechanical	Positive	Neutral	Positive
Use non-recirculating air systems where possible with high levels of heat recovery.	Facility Configuration & Internal Circulation	Building	Mechanical	Neutral	Neutral	Positive
Minimize sources of pollutants near air intake locations, including plantings, parking areas, garbage disposal bins, and others.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral

8.3. Flooding

Design Strategy	OPR Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Explore whether the building is at high risk of flooding. If high, determine whether below-grade floors should be included into design at all (i.e. survivability test). Dovetail with site selection and site programming.	General Resilience	Building	Architect	Neutral	Positive	Neutral
Wherever possible, locate key services (e.g. electrical rooms, back-up power) on higher floors at little risk of flooding. Locate electrical room, unit substation, generator and fuel on a floor above future flood construction level.	General Resilience	Building	Architect	Neutral	Positive	Neutral
Review vulnerability of traffic routes to flooding or other extreme events.	General Resilience	Off-site	Owner/Operator	Neutral	Positive	Positive
Review local regulations that may inhibit ability to address flooding (e.g. parking bylaws/requirements, setback requirements, accessibility requirements). Note that there is time to address conflicts with regulations before 2030/2050.	General Resilience	Off-site	Owner/Operator	Neutral	Neutral	Neutral
Ensure elevator controls and all major electrical components are placed above the flood construction level to avoid flooded areas and inspect elevators after a flood.	Electrical	Building	Electrical	Neutral	Positive	Neutral
Ensure hydraulic elevator machine rooms are located above the flood construction level to prevent flooding, and install locking systems (e.g. float switch systems) to prevent elevator cabs from descending below lowest floor or base flood level.	Electrical	Building	Electrical	Neutral	Positive	Neutral
Locate back-up generators and fuels above future flood construction level.	Electrical	Building	Electrical	Neutral	Positive	Neutral
Separate electrical panels for parkade and for levels above future flood construction level (FCL). Allow for safe shut-off of systems below FCL in case of a flood.	Electrical	Building	Electrical	Neutral	Positive	Neutral
Protect electrical equipment with waterproof enclosures.	Electrical	Building	Electrical	Neutral	Positive	Neutral
Include measures to protect below grade exterior foundation walls from moisture ingress. Consider holistic approaches, including the use of continuous fully-reinforced membrane waterproofing system and concrete waterproofing ad-mixture (including construction cold-joint waterproofing and at all mechanical or electrical service penetrations through the below-grade foundation walls). Provide accessibility for future repairs.	Envelope & Enclosure	Building	Envelope	Neutral	Positive	Neutral
Where necessary, select higher performance, water-resistant building materials to reduce damage to building structure, envelope and interior finishes. Ensure that materials are also mould-resistant.	Envelope & Enclosure	Building	Envelope	Neutral	Positive	Neutral
Identify any rooftop mechanical systems at risk of flooding. Ensure to fix any roof leaks when adding new rooftop equipment. Ensure all mechanical equipment is placed on pedestals/curbs higher than perimeter scuppers.	Envelope & Enclosure	Building	Mechanical	Neutral	Neutral	Neutral
Provide additional potable water storage or additional water treatment capacity to ensure potability of supply during flood events. Look for locations to store water conveniently (e.g. on the roof coupled with seismic damper) to provide continued access to potable water under conditions where the water supply has been contaminated.	Envelope & Enclosure	Building	Plumbing	Neutral	Positive	Neutral
Reinforce underground walls to withstand the pressures from floodwaters (if feasible), and include removable barriers or flood proof doors or gates at all entrances below the FCL. Note need to 'tank' structures below FCL.	Envelope & Enclosure	Building	Structural	Negative	Neutral	Neutral
Account for 'short cuts' for floodwaters to and within a building (e.g. shafts, soil gas vents, electrical conduits). Consider performance of area drains in landscaped plazas below future flood construction level.	Plumbing & Storm/Sewer	Building	Envelope	Neutral	Neutral	Neutral
Install duplex sump pumps at the lowest point of the floor, with back-up power supply and regular testing. Note that pumps will burn-out during a major flood event.	Plumbing & Storm/Sewer	Building	Plumbing	Neutral	Neutral	Neutral

Design Strategy	OPR Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Install check valves or backflow valves in third pipe, storm and sanitary sewer lines and permanently seal any floor drains that are no longer required. Note that backflow valves on sanitary systems must be specified as 'normally open' to allow air flow during normal conditions.	Plumbing & Storm/Sewer	Building	Plumbing	Neutral	Neutral	Neutral
Slope lower level towards a dedicated location to allow for pumping of flood water (e.g. parkade vent shaft). Identify potential for use of existing programming (parking) as detention.	Plumbing & Storm/Sewer	Building	Structural	Neutral	Neutral	Neutral
Conduct topological site survey and grading review to better understand stormwater flows.	Plumbing & Storm/Sewer	Site	Landscape Architect	Neutral	Neutral	Neutral
Review maps of historical streams and watercourses, many of which are now piped, to better understand water flow on and near the site.	Plumbing & Storm/Sewer	Site	Landscape Architect	Neutral	Neutral	Neutral
Install on-site sanitary and storm holding tanks in event the municipal system is compromised. Determine design requirements for sizing the sanitary holding tank.	Plumbing & Storm/Sewer	Site	Plumbing	Neutral	Positive	Positive
Coordinate efforts to establish a continuous physical barrier to floodwater inundation (e.g. structural barriers harmonised across multiple developments) to better protect the surrounding area.	Plumbing & Storm/Sewer	Off-site	Owner/Operator	Negative	Neutral	Neutral
Coordinate with regional strategies to address loss of services at sites at risk of flooding or other extreme events.	Plumbing & Storm/Sewer	Off-site	Owner/Operator	Neutral	Positive	Positive
Carry out dye testing to determine off-site capacity of the storm and sanitary systems.	Plumbing & Storm/Sewer	Off-site	Owner/Operator	Neutral	Neutral	Neutral
Install native vegetation and green infrastructure (e.g. rain gardens, infiltration swales, green roofs, rainwater harvesting, daylighted streams and constructed wetlands) to improve water detention, conveyance, and ground permeability. Use flood- and contamination-resistant species where possible.	Landscape	Site	Landscape Architect	Positive	Neutral	Neutral
Incorporate landscape features such bioswales with native plants to absorb and redirect water on-site. Identify surface flow paths from local plans to avoid inadvertently interrupting these paths.	Landscape	Site	Landscape Architect	Positive	Neutral	Neutral
Where appropriate considering site geology, use permeable paving materials and slope grade away from structures to improve overall rainwater infiltration capacity of the site, reducing the pressure on sewer systems.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral
Design site stormwater conveyance away from structures for increased volumes and flows.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral
Ensure downspouts are directed to rock pits (where geology allows) or detention facilities and away from backfill zones. Ensure rainwater volumes are not directly conveyed to the storm sewer systems, except where stormwater systems are designed to accommodate flows.	Landscape	Site	Plumbing	Neutral	Neutral	Neutral
Program space in the planning phase for storage of temporary flood barriers close to where they will be used.	Operations	Building	Architect	Neutral	Positive	Neutral

8.4. Power Outage

Design Strategy	OPR Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Provide back-up power to cooling systems at a minimum for priority service areas and priority process loads.	Electrical	Building	Electrical	Neutral	Positive	Neutral
Provide back-up power for building management control systems.	Electrical	Building	Electrical	Neutral	Positive	Neutral
Consider potential decrease in solar photovoltaic feasibility during wildfire smoke events.	Electrical	Building	Electrical	Neutral	Neutral	Neutral
Ensure that multiple types and sources of back-up power are available.	Electrical	Building	Electrical	Positive	Positive	Neutral
Include structured attachments for solar photovoltaic equipment to account for increased wind loads and to ensure panel will not lift off during extreme events.	Electrical	Building	Electrical	Neutral	Positive	Neutral
Incorporate demand management and load sharing for critical loads.	Electrical	Building	Electrical	Positive	Positive	Neutral
Incorporate hybrid system for back-up power generators (i.e. not entirely reliant on fuel or solar).	Electrical	Building	Electrical	Positive	Positive	Neutral
If not incorporated upfront, provide rough-ins for solar photovoltaic equipment to ensure facility is 'solar-ready'.	Electrical	Building	Electrical	Positive	Neutral	Neutral
Zone spaces throughout the facility as critical and non-critical to minimize required back-up power.	Electrical	Building	Electrical	Positive	Positive	Neutral
Provide increased space near generators for more fuel storage.	Electrical	Building	Architect	Negative	Positive	Neutral
Review the feasibility of using battery storage. If not feasible, plan to accommodate future use of battery storage and decreased use of fossil fuels.	Electrical	Site	Electrical	Positive	Neutral	Neutral
Encourage flexibility in power management through load shedding and time-of-day usage.	Electrical	Site	Owner/Operator	Positive	Positive	Neutral
Explore the use of neighbourhood roofs for solar power generation for the facility via 'lease arrangements', with mandates to supply the facility during an emergency.	Electrical	Off-site	Owner/Operator	Positive	Positive	Neutral
Adapt building programming to better accommodate power outages.	Operations	Building	Electrical	Neutral	Positive	Neutral
Educate operators on what loads to include on back-up power.	Operations	Building	Electrical	Neutral	Positive	Neutral
Implement monthly testing of back-up power systems and provide training for staff on this process.	Operations	Building	Owner/Operator	Neutral	Positive	Neutral
Use portable generators to power extended treatment areas and triage spaces.	Operations	Site	Owner/Operator	Negative	Positive	Neutral

8.5. Chronic Stressors: Water Shortage & Drought

Design Strategy	OPR Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Identify appropriate amount of water storage based on projected drought scenarios.	Plumbing & Storm/Sewer	Building	Plumbing	Neutral	Neutral	Neutral
Identify locations for non-potable water storage on site.	Plumbing & Storm/Sewer	Site	Plumbing	Neutral	Neutral	Neutral
Consider rainwater collection systems as a source of non-potable water and passive cooling during water shortages.	Plumbing & Storm/Sewer	Site	Plumbing	Neutral	Positive	Neutral
Advocate for the use of and/or introduce purple pipe system for wastewater reuse (specifically clean reverse osmosis 'waste' water) that can supplement non-potable uses.	Plumbing & Storm/Sewer	Site	Plumbing	Neutral	Neutral	Neutral
Install outdoor water fixtures capable of operating on water pressure (i.e. without electricity) in a location easily accessible to building occupants and community members.	Plumbing & Storm/Sewer	Site	Plumbing	Neutral	Positive	Neutral
Make use of drought-tolerant species in landscaping.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral
Explore the use of drip irrigation instead of sprinklers.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral

8.6. Chronic Stressors: Moisture & Humidity

Design Strategy	OPR Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
In window and façade design, emphasize the four Ds: deflect, drain, dry and durability.	Architectural	Building	Architect	Neutral	Neutral	Neutral
Ensure materials that may be subjected to high humidity conditions or liquid are chosen based on material and assembly performance, as proven by either testing or from prior evidence of success in similar conditions.	Architectural	Building	Architect	Neutral	Neutral	Neutral
Ensure that details and junctions of envelope components allow for adequate drainage and drying. Combine robust air barrier with external insulation, and locate the structure on the interior of the enclosure to reduce thermal bridging and condensation potential.	Envelope & Enclosure	Building	Envelope	Positive	Neutral	Neutral

8.7. Chronic Stressors: Freeze/Thaw

Design Strategy	OPR Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Set foundational piles below the future projected active permafrost layer on deeper levels of permafrost or bedrock, ensuring to include thermal breaks so that piles do not thaw frozen soil.	Structural	Site	Structural	Negative	Positive	Neutral
In areas with permafrost, design facility to 'float' on the permafrost. This could possibly be achieved using a system of 'thermosyphons', with the permafrost overlain by an 'active' layer that thaws and freezes through the seasons, while the 'permanent' layer below is perpetually frozen.	Structural	Site	Structural	Negative	Positive	Neutral
In areas that will be subject to increased freeze/thaw, minimize use of permeable, hard building materials (e.g. exposed concrete, brick).	Architectural	Building	Architect	Neutral	Positive	Neutral
Locate mechanical exhaust away from any roof or wall surfaces or eaves, as escaping warm air can carry moisture that exacerbates freeze/thaw challenges.	Mechanical	Building	Mechanical	Neutral	Neutral	Neutral
Include small roof overhangs to prevent moisture ingress into building materials, recognizing that large overhangs can increase vulnerability to extreme wind.	Envelope & Enclosure	Building	Envelope	Neutral	Neutral	Neutral

8.8. Chronic Stressors: Snowfall

Design Strategy	OPR Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Account for extreme snowfall events, even in areas where total snowfall may be decreasing. The amount of precipitation in extreme events will increase and so the amount that will fall as snow will increase. Consider that warmer temperatures will result in wetter, heavier snow.	General Resilience	Site	Owner/Operator	Neutral	Neutral	Neutral
Account for accompanying extreme wind events with snow fall as appropriate.	Structural	Building	Structural	Neutral	Neutral	Neutral
Determine early on whether to retain snow or let it slide off of the roof and design for those intended conditions.	Structural	Building	Architect	Neutral	Neutral	Neutral
Design roof geometries and appurtenances to consider extreme snowfall events, including the risk of snow dropping from one roof structure to another, which can cause major damage after periods of heavy accumulation.	Architectural	Building	Architect	Neutral	Neutral	Neutral
Locate mechanical equipment indoors for protection and ease of servicing.	Architectural	Building	Architect	Neutral	Neutral	Neutral
Consider protection of roof assemblies to allow for increased snow removal and access to equipment.	Architectural	Building	Architect	Neutral	Neutral	Neutral
For snow sliding off of roof, ensure no roof penetrations or roof feature restrain the snow which could lead excessive loads on these elements.	Envelope & Enclosure	Building	Architect	Neutral	Neutral	Neutral
Look at effects of ponding water above the exterior wall from ice damming .	Envelope & Enclosure	Building	Envelope	Neutral	Neutral	Neutral
Look at ice curl if snow is allowed to slip off of roof to a colder eave section which can push the wall below.	Envelope & Enclosure	Building	Architect	Neutral	Neutral	Neutral
Ensure that roof drainage systems consider future precipitation and snowfall projections.	Plumbing & Storm/Sewer	Building	Plumbing	Neutral	Neutral	Neutral

8.9. Chronic Stressors: Wind & Storms

Design Strategy	OPR Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Mitigate increased wind load using aerodynamically efficient structures to reduce deflection and resonance, including curved corners, minimized eave overhangs and better foundation design.	Architectural	Building	Architect	Neutral	Neutral	Neutral
Ensure that building attachment details are capable of withstanding stronger winds, focusing on anchorage between different elements (e.g. floors to walls, cladding to building).	Architectural	Building	Architect	Neutral	Neutral	Neutral
Consider wind pressure and wind tunnel effects when selecting the location and design of the main entrance.	Architectural	Building	Architect	Neutral	Neutral	Neutral
Avoid rooftop/exterior equipment wherever possible, making use of larger penthouses and/or louvres to protect equipment.	Mechanical	Building	Mechanical	Neutral	Neutral	Neutral
Ensure rooftop equipment and renewable energy systems (e.g. solar PV) are designed to withstand extreme wind or precipitation.	Mechanical	Building	Electrical	Neutral	Positive	Neutral
Select impact-resistant building materials, external claddings and glazing where continuous load path may be insufficient to protect the structure (e.g. heat soaked glazing).	Envelope & Enclosure	Building	Envelope	Neutral	Neutral	Neutral
Consider topography and landscape details that can help to mitigate high winds. Design the site with wind breaks and buffers to help people can get safely from transit and parking to the building.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral