

# Summary Report

## City of Victoria Completes the First Two Milestones in ICLEI Local Government Climate Change Adaptation Planning Process

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### 1 Introduction

#### 1.1 Purpose

The science is clear: our global climate is changing. Despite all efforts to reduce greenhouse gas emissions, we will continue to experience weather events and impacts related to climate change over the coming decades, even if emissions were stopped today. In Victoria these changes could include more storms and storm surges, leading to flooding; hotter, drier summers, leading to potential health issues in vulnerable communities and the loss of trees, plants and wildlife. To make sure our community is prepared to address the consequences of climate change, the City of Victoria is engaged in climate change adaptation planning. This planning will help us to understand the risks we face in a changing climate and help us prepare for a range of possible futures where “business as usual” is no longer the right option. The strategies and actions resulting from this planning will be included in Victoria’s Climate and Energy Resiliency Plan. This plan, to be completed in 2012, will be an integrated mitigation and adaptation plan for the community and include strategies and actions for a) reducing our community’s greenhouse gases generated by buildings, transportation, and the disposal of solid waste; and b) building resiliency to prepare for the impacts of a changing climate.

#### 1.2 Mandate

In April 2011 City Council passed the Climate Action Program Project Charter directing staff to create a community climate change adaptation team and develop a climate change adaptation plan for Victoria using the ICLEI pilot planning process.

#### 1.3 ICLEI Climate Change Adaptation Planning Process

The City of Victoria along with 19 other Canadian municipalities and regional governments, including the Capital Regional District, are piloting the *Guide and Workbook for Municipal Climate Adaptation*, developed by ICLEI Canada<sup>1</sup>. The ICLEI framework uses a milestone approach for climate change adaptation planning with the following five milestones: Initiate, Research, Plan, Implement and Monitor<sup>2</sup>. The City of Victoria has completed the first two milestones in the planning process (Figure 1).

Of the 19 ICLEI Canada pilot participants, Victoria’s climate change adaptation (adaptation) planning process is unique because it seeks to address the climate change challenges facing the entire community, not only the impacts on municipal services and infrastructure.

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<sup>1</sup> **International Council for Local Environmental Initiatives**, is an international association of local governments and national and regional local government organizations that have made a commitment to sustainable development. The association was established 1990. Today, more than 1200 cities, towns, counties, and their associations in 70 countries participate in ICLEI initiatives and programs.

<sup>2</sup> <http://www.iclei.org/index.php?id=11710> (link to ICLEI adaptation planning process guide and workbook)



Figure 1. ICLEI Milestones

## 1.4 Team

To coordinate and develop the adaptation plan, a Climate Change Adaptation Team (CCAT) was formed. As a seat of provincial and regional government, as well as home to the Pacific Climate Impact Consortium (PCIC) and the Pacific Institute for Climate Solutions (PICS), the city is host to a wealth of experts on climate change. In building the CCAT, city staff leveraged local expertise and recruited municipal directors, managers, scientists and other professionals to bring a diversity of disciplines, experience, and perspectives to the adaptation team. The work in this report therefore reflects the input of government, university and civil society experts. A full list of team members is in Appendix, Table 2.

## 1.5 What has the team discovered to date?

Through research and analysis using vulnerability and risk assessment practices the team has determined risks to the community from climate change events as they are currently projected to 2050 are low to medium.

However, the impacts and risks later described might best be considered the minimum we should be prepared to address. Where opportunities exist, further steps should be taken to proactively prepare for more severe climate change impacts.



Figure 2 November 24th, 2011 12:30 pm King Tide, 3.09 m plus 37 cm storm surge (3.46 m total) – Inset shows typical high tide.

Several areas of specific risk were identified:

- Buildings and infrastructure were considered at risk from sea-level rise and extreme weather events, particularly increased storm frequency and intensity.
- Heat waves were considered the most significant public health risk as neither buildings nor population have a well-developed capacity to manage heat. Victoria approached a heat wave threshold for health impacts in 2009. Impacts of a prolonged (72 hour) heat wave are likely to be exacerbated as Victoria's population of older adults (a vulnerable group) is projected to rise.
- The natural environment was considered to be impacted already and at further risk from gradual temperature increase and summer drought. Victoria's urban forest is experiencing change. Mountain ash and Lawson cypress are in rapid decline, birch and cherry trees are less likely to establish when replanted. Beyond the impacts of climate change, Victoria's urban forest canopy cover will decline about 20% over the next 20 years as over-mature trees are replaced. Tree loss has broad environmental, cultural and physical implications, not least through slowing and reducing the volume of rainfall entering the storm system.
- Significantly, the majority of impacts relate to storms. Risks for each storm impact were assessed individually, but in reality these impacts will often occur in tandem. Thus, it is reasonable to assume that although the individual assessed risks are low, the combined impacts of increased storm frequency and intensity could translate to cumulatively larger risk. As a result, the community's vulnerability and risk from increased frequency and severity of storms may be under-rated.
- Small localized flooding is a yearly event in the region. Larger floods pose a risk to public health and create substantial property damage. Combined with other storm features, downed trees, power outages, road closures and insurance losses, the late fall and early winter storm season in Victoria is likely to pose additional threats and greater challenges as climate change progresses.

While the most current and accurate information on climate change was used to perform the assessments, uncertainty around climate projections needs to be considered. The message from climate scientists is unambiguous; we need to be adaptable to climate change and greenhouse gas emissions need to be curbed. While future climate is somewhat uncertain, the consensus is it will be very different from what we know today.

The results of the work done by the Team to date indicate areas where climate change adaptation actions can be most effectively directed to provide the greatest reduction in climate change risk. Furthermore, the diversity of impacts across the community highlight that a community approach is necessary to address these risks effectively.

## 2 Climate Change Events

The CCAT used the latest and most reputable information describing future climate available. The Pacific Climate Impacts Consortium (PCIC)<sup>3</sup> and ICLEI provided a preliminary set of projected climate changes that are modeled for Victoria (see Table 1).

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<sup>3</sup> PCIC is a regional climate service centre at the University of Victoria that conducts quantitative studies on the impacts of climate change and climate variability in the Pacific and Yukon region

**Table 1 Summary table of Climate Events for Victoria<sup>4</sup>**

<b>Warmer temperatures</b>
<ul style="list-style-type: none"><li>• Increase by 2050s from 1961-1990 baseline of 1.0 to 2.3C<sup>4</sup></li><li>• Increase in hot days projected (days over 30°C)<sup>5</sup></li><li>• Indication of humidity increase<sup>5</sup></li></ul>
<b>Wetter winters, drier summers</b>
<ul style="list-style-type: none"><li>• 2050s projection of up to 14% increase in winter precipitation and up to 32% decrease in summer rainfall<sup>4</sup></li></ul>
<b>Increased Frequency and Intensity of Storm Events</b>
<ul style="list-style-type: none"><li>• Increase in frequency and intensity of storm events by as much as 15% by 2050s<sup>5</sup></li><li>• High tide season is during winter, with projected increase in frequency of winter storms by 8 to 15% and consequent increase in storm surges<sup>6</sup></li></ul>
<b>Sea Level Rise</b>
<ul style="list-style-type: none"><li>• The extreme high estimate of sea level rise for Victoria is 0.89 - 0.94m by 2100<sup>7</sup></li></ul>

## 2.1 Uncertainty

The Intergovernmental Panel on Climate Change (IPCC) endorses the use of Global Climate Models (from which some of the above information was obtained) as indicators of future projected climate and climate changes. However, even calibrated models have a level of uncertainty as climate cannot be modeled perfectly. Also, it is not possible to know everything that affects future climate exactly, such as future population levels and greenhouse gas use. Therefore, the IPCC recommends the use of several models and emissions scenarios to develop a reasonable range of projected climate outcomes for the future.

Average values of climate change are important in planning, as are extreme weather events, for example, high winds, heat waves, and extreme precipitation events. As indicated by the IPCC (2007), there is currently large uncertainty about future changes in extreme events, and climate modeling of extreme events is an emerging science.

To minimize this uncertainty, and to bring the clearest focus to the adaptation plan's actions, PCIC was tasked with providing a report on regional climate impacts and extremes. Results of the study will be available in summer 2012.

The City's adaptation planning work continues in the absence of complete certainty around these climate change events. As climate science develops further, the information on events will continue to be refined, and the projected impacts and possible plan actions amended as necessary to address the most current and reliable climate change projections.

In short, while it is certain that the climate will change, the exact nature of projected events and projected impacts discussed contain a degree of inherent uncertainty.

## 2.2 Community service areas

<sup>4</sup> Information provided by ICLEI Canada and Plan2Adapt.ca (2011)

<sup>5</sup> Indicates based on extrapolation of historical trends or single model results, (simplified methods only appropriate for indicating need for further analysis) Bruce, J.P. (2011). Climate Change Information for Adaptation: Climate trends and projected values for Canada 2010 to 2050. Institute for Catastrophic Loss Reduction. 56p

<sup>6</sup> Bruce, J.P. (2011). Climate Change Information for Adaptation: Climate trends and projected values for Canada 2010 to 2050. Institute for Catastrophic Loss Reduction. 56p

<sup>7</sup> [Projected Sea Level Changes for British Columbia in the 21st Century](#)

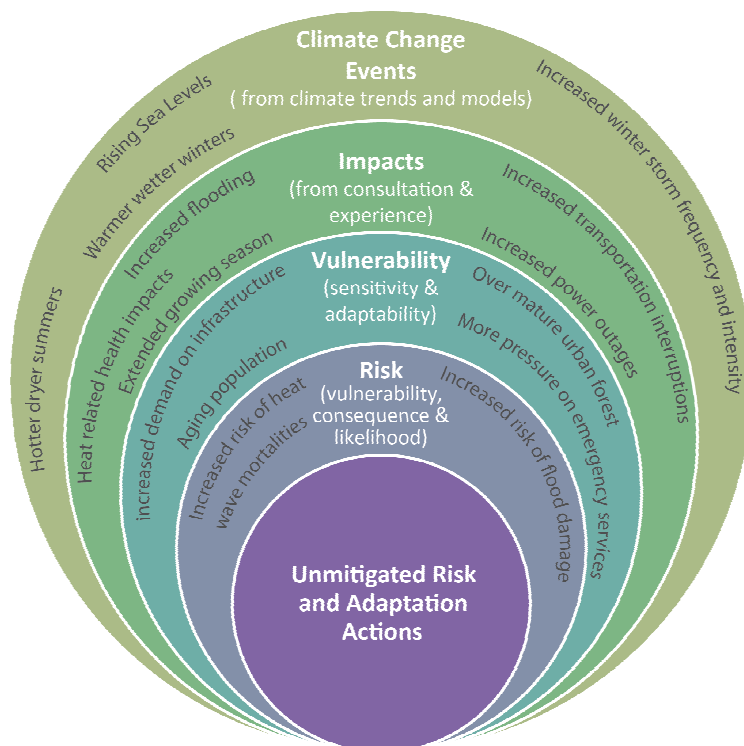


Researching the impacts of climate change requires not only gathering information on climate changes that are likely to occur in Victoria, for example, changes in temperature and precipitation, but also information on what these changes are likely to mean for the resources, infrastructure, residents and businesses of our community.

To understand how climate change events and their consequent impacts affect the community, a group of key research areas were created where governments or communities deliver services, manages assets, or govern resources. The thirteen areas, termed *service areas* (see Appendix, Table 3), include, to name a few, Parks & Natural Environment, Underground Utilities, Buildings, Emergency Management and Health Care.

### 3 Climate Change Impacts

Not all climate change events are negative and not all impacts are undesirable. For example, warmer weather will bring lower winter heating demands and longer growing seasons. Through focusing on impacts that adversely affect the livability of Victoria the objective is to identify those



negative impacts that the community has an ability to reasonably address. Figure 3 illustrates how the planning process brings focus from climate change events to areas where action can be taken. An example is rising sea levels (event) resulting in increased flooding (an impact). Flooding affects harbour transportation services (a vulnerability) and consequently increases the risk of economic losses. Understanding the risks associated with the climate change events is the first step in developing actions to acceptably reduce risks.

By considering how the overall functionality of service areas might be affected by climate change events, insight is gained on the overall impact of climate change to Victoria.

**Figure 3. From climate change events to adaptation actions**

#### Findings

The CCAT identified sixteen main impacts that would be widely felt and require a broad community response<sup>8</sup> (Appendix, Table 4). Eleven of the sixteen impacts relate to extreme weather events, the majority associated with the impact of increasing severity and frequency of winter storms.

#### 3.1 Assessing Climate Change Impacts

<sup>8</sup> See Milestone 2 (draft) discussion paper for full list of impacts

To assess climate change impacts, both vulnerability and risk are evaluated. Vulnerability is a function of both a community's exposure or susceptibility to harm (sensitivity) and its capacity to respond, and thereby adapt to a changing climate (resiliency).

$$\text{Vulnerability} = \text{Sensitivity} - \text{Resiliency}$$

Risk considers the outcomes of vulnerability and is a combination of the likelihood and consequence of an impact. Likelihood refers to the probability of the projected impact occurring, and consequence refers to the known or estimated effects of a particular impact.

$$\text{Risk} = \text{Likelihood} \times \text{Consequence}$$

Vulnerability and risk assessments are necessarily conducted using a snapshot of present conditions and a projection of future impacts. As such, they need to be periodically repeated to ensure the vulnerability and risk associated with new conditions and projections are understood.

### 3.2 Vulnerability Assessment

Analyses of both the sensitivity and resiliency of each of the thirteen service areas to the projected climate change events identified for Victoria were completed<sup>9</sup>. The results of the analyses describe the overall vulnerability of the community to impacts from projected climate change events. Vulnerability was scored on a five step scale from low to high.

The results show a diverse array of climate change impacts spread across many service areas in the community. Six of the thirteen service areas have high or medium-high vulnerability ratings against one or more possible impacts. Vulnerability can be expressed in terms of:

- the weather events that expose the greatest vulnerability,
- those impacts to which Victoria is most vulnerable, and
- the service areas most vulnerable.

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<sup>9</sup> Excluding Economy and Food Systems due to lack of information

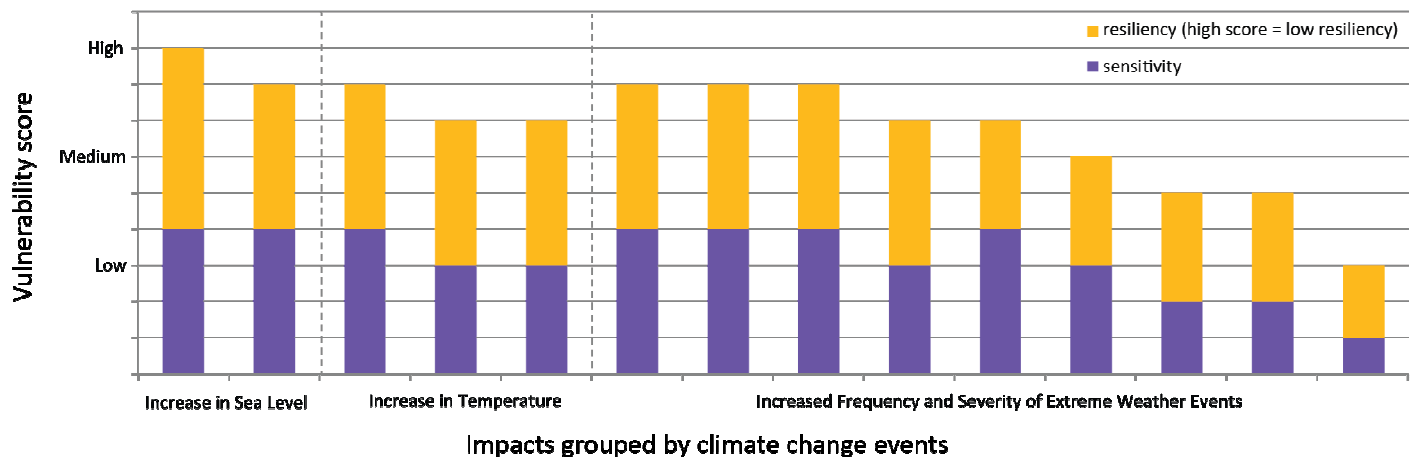
## Findings

A full list of the identified climate change impacts and vulnerability scores is available in the background discussion paper<sup>8</sup>.

**Victoria is most vulnerable to the following climate change events (Figure 4):**

- Sea level rise
- Increased frequency and severity of storms

**Figure 4 Impact Vulnerability Scores grouped by Climate Change Event**



**The climate change impacts generating the greatest vulnerability for Victoria include:**

### High vulnerability

- Due to sea level rise, access to sea walls piers, docks and other coastal infrastructure and services may be restricted due to flooding and damage.

### Medium-high vulnerability

- Due to storm or windstorm damage, inflow and infiltration cause sections of sewer system to exceed capacity, sewage backflows into homes and discharge from outfalls untreated.
- Due to storm or windstorm damage, building envelopes fail.
- Due to sea level rise, storm drains may backflow and cause flooding.
- Coastal erosion occurs due to increased sea levels.
- Cycle of intense storms with sustained winds exceeding 100km/h increases demand on emergency services over a sustained period of several weeks and response capacity is reached.
- Ecological changes, due to temperature increase and lack of precipitation, result in some existing trees and plants being lost from streets and parks. New invasive species may arrive, sensitive habitats may suffer additional stress (gradual climate change).

### Medium vulnerability

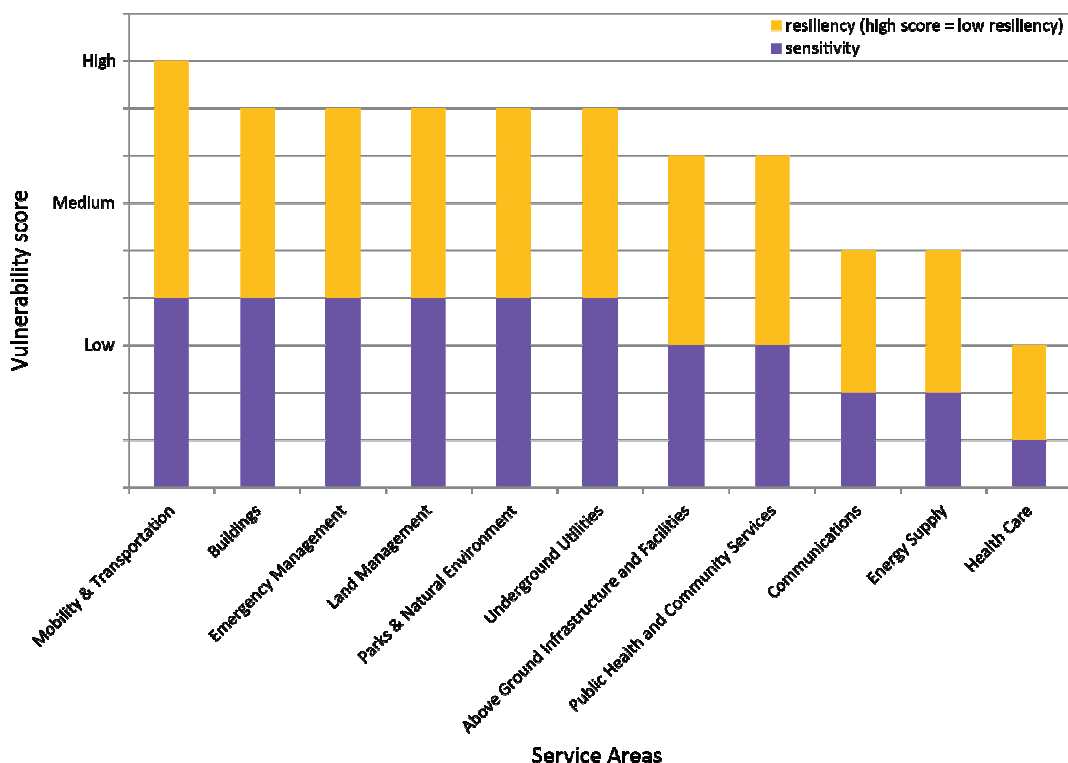
- An increased frequency and severity of heat waves result in vulnerable populations suffering additional stress or mortality.
- Due to increased temperatures, new ailments arrive or existing ailments are exacerbated.

**The following service areas have greatest vulnerability to climate change (Figure ):**

- Buildings,
- Emergency Management,
- Land Management,
- Mobility and Transportation,
- Parks & Natural Environment, and
- Underground Utilities.

**Figure 5**

**Service Area Vulnerability**



In summary, restricted access to piers, docks and other infrastructure was the impact identified as having the highest vulnerability for Victoria because it is both sensitive to sea level rise and of relatively low resiliency due to the high replacement cost of infrastructure.

In reviewing the results of the vulnerability assessment, it is important to recognize that high vulnerability scores do not automatically denote a high level of risk or a need for action. In many instances these vulnerabilities may have already been recognized and managed through existing plans or actions<sup>10</sup>. High vulnerability scores do, however, reflect there is both high sensitivity and low resiliency associated with the impact, indicating that the impact's risk needs to be well understood.

With the vulnerability assessment complete, the CCAT then moved on to evaluating risk. The risk assessment explores vulnerabilities further and develops an understanding of their associated liabilities.

<sup>10</sup> See Milestone 1 (draft) discussion paper.



### 3.3 Risk Assessment

Risk is a combination of the likelihood and consequence of an impact (Figure 6). Likelihood refers to the probability of the projected impact occurring, and consequence refers to the known or estimated effects of a particular impact. Consequence may relate to the effect on any of the following 5 risk areas - *public safety; local economy and growth; community and lifestyle; environment and sustainability and, public administration and services.*

When analyzing the risk associated with a particular impact, recurrence was an important element. Impacts that could recur, for example, the consequences of a heat wave, were separately identified from those impacts that could only occur once between now and 2050, for example, significant loss of urban forest due to gradual change in Victoria's temperature and precipitation regime.

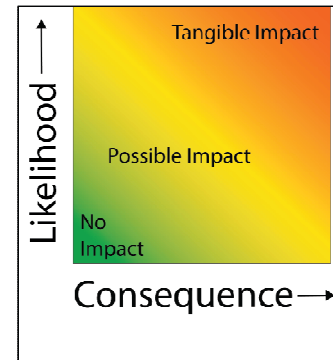


Figure 6. Risk relationship of consequence and occurrence

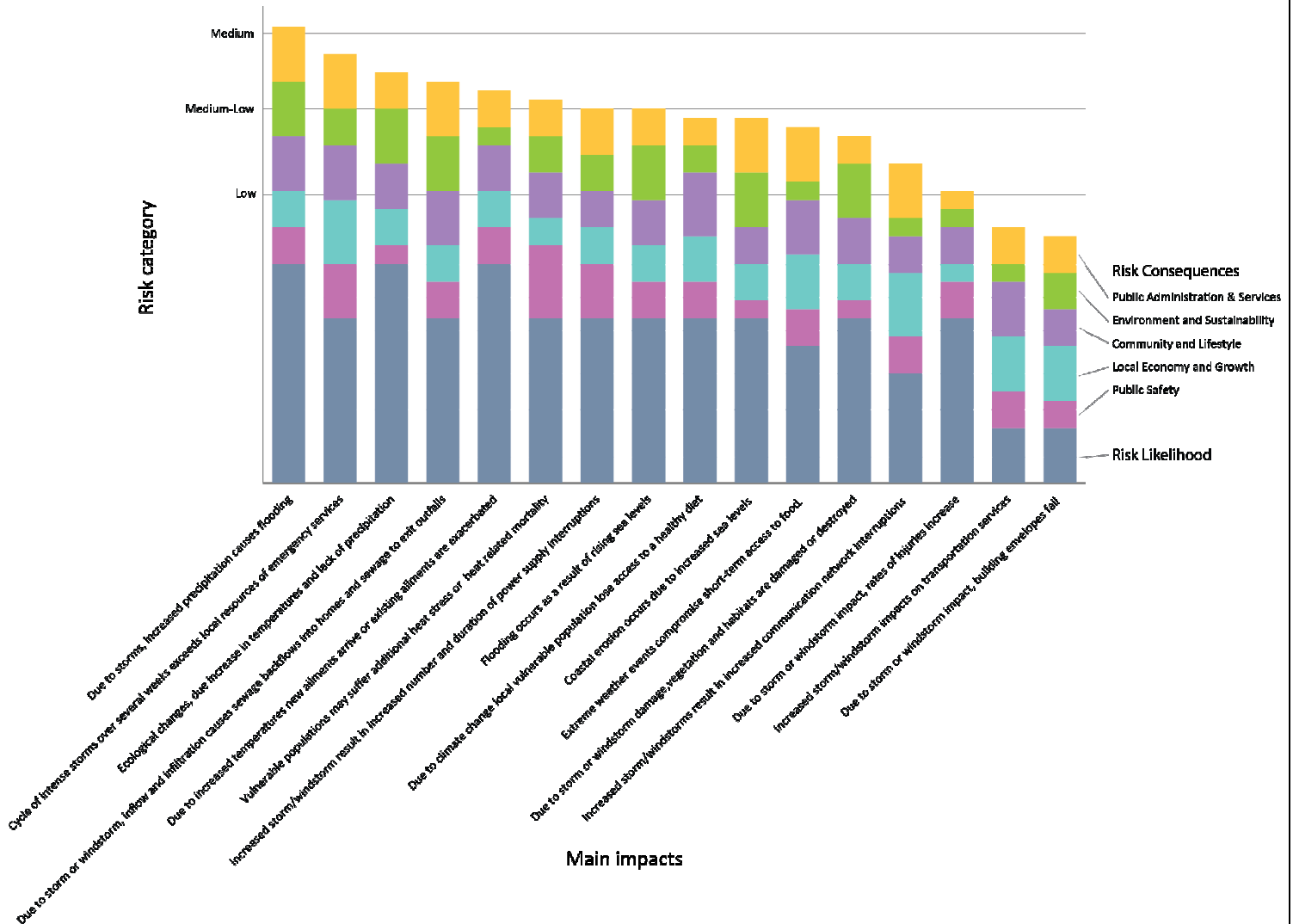
#### Findings

Overall, the risk assessment shows that risks to the community due to climate change events as they are currently projected to 2050 range from low to medium (Figure 7). This risk assessment, however, does not consider very unpredictable extreme events. For example, a 1:500 year flood event has an approximately 7% probability of occurring before 2050 (regardless of climate change), but is considered beyond the scope of the plan to assess or manage due to;

- lack of certainty on return period of very extreme events (lack of data and projections),
- challenges in accurately estimating the impacts of such events, and, to a lesser extent,
- limited opportunities to proactively prepare for such events.

Figure 7

#### Risk Assessment Results



**Highest overall risk:** The following recurrent impact has been identified as having the highest risk due to the severity of the consequences and the likelihood of it occurring about once every year;

- Due to increased strength and frequency of storms, increased precipitation causes flooding.

**Highest likelihood:** The following impacts are considered to have a greater than 50% chance of occurring before 2050;

- Ecological changes – hotter dryer summer weather is likely to result in a substantial decline in numbers of some existing tree and plant species (birch and cherry are notably vulnerable)
- Due to increased temperatures new ailments arrive or existing ailments are exacerbated (recurrent)

**Highest consequence:** The impact with the greatest consequence is considered likely to recur approximately once every 10 years;

- Cycle of intense storms with sustained winds exceeding 100km/h increases demand on emergency services over a sustained period of several weeks to maximum local capacity

**One impact that may arise about once in every ten years was considered to present a major public safety concern to the community:**

- Due to increased frequency of hot days, vulnerable populations may suffer additional stress or mortality

From the risk assessment, actions will be developed with the objective of reducing vulnerability and risk of harm from climate change events and impacts. In managing risk, it is seldom feasible to eliminate all risk. Instead actions are sought to reduce risk exposure to an acceptable level.

## **4 Next Steps**

With the completion of Milestones 1 and 2, the adaptation planning process is now in Milestone 3, Plan Development. In this milestone, actions that can reduce Victoria's vulnerability to, and risk from, climate change events are being proposed and evaluated. Existing actions and measures that either directly or indirectly address climate change issues across service areas are being reviewed for effectiveness. Preferred new actions will be added into the Climate and Energy Resiliency Plan, the combined plan that addresses both climate change adaptation and greenhouse gas reduction, for release later this year.

## **5 Acknowledgements**

The City of Victoria wishes to thank the Climate Change Adaptation Team for their work thus far in developing the climate change adaptation component of the Climate Energy and Resiliency Plan. Without their expertise, dedication, and insights, over the past twelve months this work would not have been possible (Appendix, Table 2).

## 6 Appendix

**Table 2 Climate Change Adaptation Team**

Members	City Internal/ External	Dept./Company	Name
Sr. Planner Environmental Issues, Sustainability	Internal	Sustainability	Allison Ashcroft
Climate Action Analyst, Sustainability	Internal	Sustainability	Steve Young
Asst. Director, Stormwater	Internal	Engineering + PW	Ed Robertson
Asst. Director, Underground	Internal	Engineering + PW	John Sturdy
Manager, Emergency Management	Internal	VEMA	Rob Johns
Supervisor, Parks Operations	Internal	Parks, Rec, Cult	David Speed
Director of Risk Management	Internal	Risk Management	Bill Fanous*
Planner - Community Planning Division	Internal	Community Planning	Cam Scott
Sustainability Coordinator	External	CRD	Sarah Webb
Manager, Science and Adaptation	External	Province, Climate Action Secretariat	Thomas White
Associate Research Chair (Geography)	External	UVic (Pacific Institute for Climate Solutions)	Aleck Ostry
Researcher	External	PICS	Rachelle Beveridge
Climate Scientist	External	UVic (Pacific Climate Impacts Consortium)	Trevor Murdock
Economic and Business Advisor	External	Transformation	Carol Anne Hilton
Climate Action Champion	External	TBD	TBD
Senior Public Health Officer	External	VIHA	Erwin Dyck

\* Past Member

**Table 3 service areas**

Service area	Description
Parks & Natural Environment	Urban Forest, green space, parks and boulevards
Underground Utilities	Storm water, water and sewer infrastructure
Above Ground Infrastructure and Facilities	Roads, traffic signals, street lights, sidewalks, <i>etc.</i>
Mobility & Transportation	Cars, buses, rail, cycling, walking, moving of goods and people
Buildings	Buildings, residences, recreation centres, <i>etc.</i>
Energy Supply	Energy generation, transmission and distribution
Emergency Management	Victoria Emergency Management Association, police, and fire
Economy	Business profit, employment income, municipal taxes, <i>etc.</i>
Public Health and Community Services	Community health and support services and organisations, <i>e.g.</i> Open Door
Health Care	Hospital services, ambulance service, clinics, long-term care facilities
Land Management	Formal and informal land uses, <i>e.g.</i> residential areas, outdoor seating
Communications	Telecommunications system including land lines and wireless networks
Food Systems	Mechanisms and facilities used to feed community

**Table 4 Main impacts and risk assessment**

Main Impact Statement	Scenario	Risk Category
Ecological changes, due to temperature increase and lack of precipitation, result in some existing trees and plants being lost from streets and parks. New invasive species may arrive, sensitive habitats may suffer additional stress (gradual climate change)	A series of hot and dry summer results in the death of 20% of the city's birch and cherry trees in parks and along boulevards. English hawthorn, Tree of heaven and Flowering ash spread develop invasive species status	Medium Low
Due to increased frequency of hot days, vulnerable populations may suffer additional stress or mortality	Victoria suffers a heat wave where temperatures are over 28 °C for three consecutive days, temperatures drop little overnight. Several dozen people suffer heat distress. There are a number of heat related mortalities.	Medium Low
Due to increased temperatures new ailments arrive or existing ailments are exacerbated	West Nile virus and Lyme disease arrive in Victoria in low numbers and incidences. Respiratory illness and heart attacks increase in response to a winter decline in indoor air quality. Reports of bedbugs and food borne illnesses rise.	Medium Low
Flooding occurs as a result of rising sea levels	Flooding due to a high tide , combined with a 1.1m storm surge, 0.3m -1m waves and 45cm SLR. Total height would be 2.15m above average high tide. Lower causeway, the mouth of Cecelia Creek and portions of Dallas Road and Memorial Crescent are flooded (by Ross Bay Cemetery)	Low
Coastal erosion occurs due to increased sea levels	Dallas Road Bluffs suffer severe erosion. Access to upper and lower trails is partially blocked.	Low
Increased storm/windstorm result in increased number and duration of power supply interruptions	Downtown Victoria and areas in the surrounding region suffer a 6 hour power outage as a result of a mid-winter storm	Low
Increased storm/windstorms result in increased communication network interruptions	Landlines are inoperative for 12 hours in several residential blocks due to a mid-winter storm. Cell phone network is overwhelmed with traffic and service is erratic.	Low
Increased storm/windstorm impacts on transportation services	Due to multiple downed trees and power lines, four major arteries into Victoria are closed for up to 6 hours.	Low



Main Impact Statement	Scenario	Risk Category
Due to storm or windstorm impact, building envelopes fail.	A windstorm with gusts in excess of 145km/hour removes asphalt shingle roofing from approximately 200 homes along exposed coastline.	Low
Due to storm or windstorm damage, inflow and infiltration causes sewer system to exceed system capacity, sewage backflows into homes and exits outfalls untreated.	Heavy rainfall in conjunction with extreme high tides causes sewer system backflow issues in James Bay. Over 50 households report sewage entering homes	Medium Low
Due to storms, increased precipitation causes flooding	Early fall storm drops 80 mm of rainfall on Victoria within 24 hours. Leaves block many catch basins causing extensive flooding of residential streets. Many homes are flooded due to inadequate curtain drains.	Medium
Due to storm or windstorm impact, rates of injuries increase	Peak ER hospital visits increase 10% above previous records during severe winter storm	Low
Due to storm or windstorm damage, (either directly or through increased vulnerability to disease or insects) vegetation is damaged or destroyed and there is localised loss of vulnerable species and critical habitats for species at risk.	Approximately 40% of urban forest is impacted by an early fall storm, trees are in leaf. Numerous large branches fall on streets, vehicles and sidewalks. Several dozen mature trees fall in yards, parks and boulevards. Iconic Garry oak are lost from Beacon Hill Park.	Low
Cycle of intense storms with sustained winds exceeding 100km/h increases demand on emergency services over a sustained period of several weeks (e.g. Nov 2007 storms)	A sequence of four winter storms, with winds in excess of 100km/h, over a 6 week period reaches the capacity of local emergency response resources to maintain full functionality. Emergency response teams are brought in from other parts of the Province. Response times increase 50%.	Medium Low
Climate change will compromise local, regional and global food systems, impacting the local population's access to a healthy diet (particularly vulnerable populations).	Vulnerable portions of the population lose access to a healthy diet. Diabetes and other malnourishment related diseases affect majority of vulnerable populations.	Low
Extreme weather events compromise short-term access to food in vulnerable populations and potentially in wider community.	After a period of intense storms supermarket shelves are notably depleted. Radio stations and emergency services receive calls from isolated elderly population who have exhausted their food supplies.	Low