TOWN OF CANMORE

CLIMATE CHANGE ADAPTATION BACKGROUND REPORT AND RESILIENCE PLAN

September 2016

Climate Resilience Vision

The Town of Canmore is resilient to the threats of projected climate change, and prepared to take advantage of any opportunities that may arise.

PREPARED BY:

Jeff Zukiwsky, Dr. Richard Boyd, Dr. Mel Reasoner, and Carole Stark

ALL ONE SKY FOUNDATION

PO Box 19012, 809 49th Avenue SW
Calgary, AB., T2S 1A0

www.allonesky.ca

SUBMITTED TO:

Lori Rissling Wynn
Sustainability Coordinator

TOWN OF CANMORE
902 7th Avenue
Canmore, AB., T1W 3K1

LRisslingWynn@canmore.ca
Tel. 403.678.1527

This Climate Change Adaptation and Resilience Plan: Background Report has been partly produced through the **Climate Resilience Express Action Kit—Kick-starting Adaptation in Smaller Alberta Municipalities** (Climate Resilience Express) project with financial support from The Calgary Foundation, Natural Resources Canada, All One Sky Foundation, the Municipal Climate Change Action Centre, and Alberta Ecotrust.

Climate Resilience Express is a collaboration between All One Sky Foundation, the Municipal Climate Change Action Centre, the Miistakis Institute and the Alberta Biodiversity Monitoring Institute.

For more information on the Climate Resilience Express visit: http://allonesky.ca/climate-resilience-express-project/ or mccac.ca/programs/climate-resilience-express.

Summary

The effects of climate change are already apparent in Canmore. The average annual temperature in the Bow Valley has increased by about +1.5°C since the early 1900s; roughly 1.7 times faster than the observed global rate of warming over the same time period. Winter months in the Bow Valley have seen the greatest warming trend—warming three times more than summer months since 1965.

Climate projections for the Bow Valley point towards further increases in temperature and changing precipitation patterns. By the 2050s mean annual temperature is anticipated to rise to +4.7°C, an increase of 1.9°C over the 1961-1990 average. The projected increase in mean annual temperature is expected to be accompanied by an increase in mean annual precipitation of about 5%. However, summer precipitation is projected to decline by about 5%. Projected changes in average temperature and precipitation for the Bow Valley will have broad consequences across the natural environment, including for the extent of glaciers, winter snowpack, streamflow, wildfires and forest pests, and regional ecosystems.

Projected climate and environmental changes could have numerous impacts on Canmore, with consequences for municipal infrastructure and services, private property, the local economy and environment, and the health and lifestyle of citizens. In anticipation of the potential risks and opportunities presented by these changes, the Town of Canmore is taking steps to ensure a safe, prosperous and resilient future by developing a Climate Change Adaptation and Resilience Plan. This report provides the foundations for the Plan, including:

- ✓ A vision statement;
- ✓ Strategic goals;
- ✓ Specific climate adaptation and resilience objectives;
- ✓ A list of priority actions; and
- ✓ Resource and timing issues.

The overall approach to developing the Plan is grounded in existing standards for risk management based on the International Organization for Standardization's (ISO) 31000, Risk Management – Principles and Guidelines. Workshops with Town staff and other local stakeholders were conducted to identify, assess and evaluate climate-related risks and opportunities facing Canmore over the next several decades. In total, twenty-two risks and opportunities were identified, of which eight risks and three opportunities were defined as priorities for action planning:

Priority risks for action planning	
Forest fire	Extreme wind
Bow river flooding	Water supply shortage
Creek flooding	Heavy snowfall event, blizzard
Stormwater system overwhelmed, localized flooding	Freeze-thaw cycles
Priority opportunities for action planning	
Increase in summer season recreation opportunities	Extended construction season
Increase in winter tourism competitive advantage	

A series of facilitated meetings with Town staff and other local stakeholders were held to establish a portfolio of actions to (a) increase resilience to the priority risks and (b) build capacity to take advantage of the priority opportunities. The meetings revealed that Canmore is already undertaking numerous actions to these ends (e.g., many actions have already been formulated to mitigate flooding risk on mountain creeks), even though these actions have not traditionally been labelled as “climate adaptation or resilience actions”. In addition to existing actions and commitments, fifty-one new actions were identified.

To support priority setting for implementation, all fifty-one actions were characterized in terms of: (1) investment costs; (2) annual recurring costs; (3) timeframe for implementation; and (4) implementation lead. Furthermore, all actions were screened and rank-ordered against a number of criteria commonly used prioritize climate adaptation and resilience actions, including effectiveness, affordability, acceptability and flexibility.

The defined actions serve as a ‘shopping-list’. Town staff and other community stakeholders should look to establish priorities from the listed actions on an annual basis, and begin implementation as warranted.

Table of Contents

1. INTRODUCTION

The effects of climate change are already apparent in Canmore, with observable changes in temperature, precipitation, and extreme weather events over the last century. The average annual temperature in the Bow Valley has increased by about +1.5°C since the early 1900s, with winter months seeing greater warming than summer months. Over the same period, the amount and timing of precipitation in the area have also changed.

We are sure to experience further changes to our climate in the decades ahead—the result of past greenhouse gas (GHG) emissions. There is a time lag between GHG emissions and when we see the impacts as the planet responds. How much the climate will change beyond the next few decades depends on how much and how fast global GHG emissions are reduced from current levels.

Mitigation will help avoid the unmanageable … **adaptation** is essential to manage the unavoidable.

The impacts of climate change on communities across Alberta could be numerous and diverse, giving rise to potentially significant, though uncertain consequences, for municipal infrastructure and services, private property, the local economy and environment, and the health and well-being of citizens. Impacts may arise through changing patterns of precipitation with increased risk of flooding and drought, increased strain on water resources, rising average temperatures and more common heatwaves, more frequent wildfires, or more intense ice, snow, hail or wind storms. Climate change may also present opportunities for communities.

Alberta municipalities are at the forefront of these impacts—both because extreme weather events can be especially disruptive to urban systems and because they are where much of our population live, work and raise their families. Smaller communities are particularly vulnerable and may lack the capacity to adequately respond to increasing impacts. It is therefore essential that municipalities take steps now to anticipate and better prepare for future climate conditions, to ensure they continue to prosper as a desirable place to live and work for generations to come.

The Town of Canmore, through undertaking this climate adaptation planning study, is taking steps towards ensuring a safe, prosperous and resilient future. This report identifies a number of preventative measures to manage priority threats and opportunities anticipated to result from climate change over the next several decades.

2. Developing A Plan

Our overall approach to developing a climate change adaptation and resilience plan (or "Action Plan" for short) is grounded in existing standards for risk management based on the International Organization for Standardization's (ISO) 31000, Risk Management – Principles and Guidelines. It follows a four-step, iterative process (shown in Figure 1):

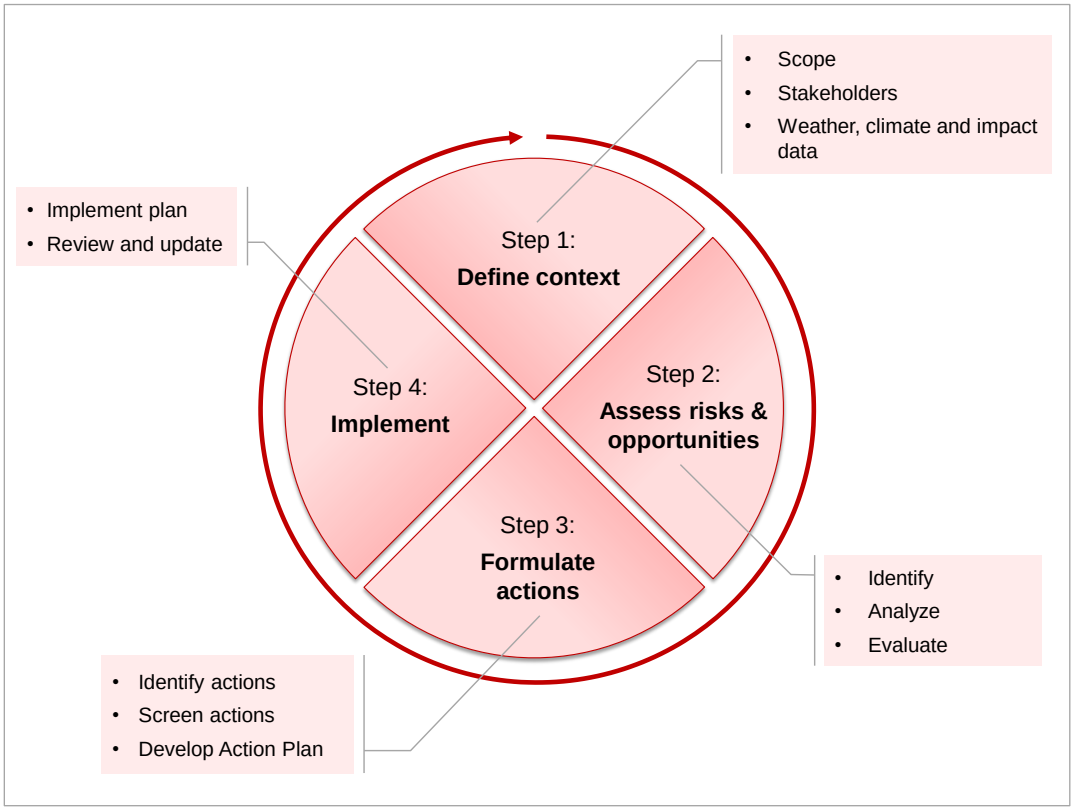
Step 1: Establish the local context for the planning exercise;

Step 2: Assess potential climate-related risks and opportunities to establish priorities for action;

Step 3: Formulate actions to manage priority risks and opportunities, and prepare the Action Plan; and

Step 4: Implement the Action Plan, review progress, and update the Plan to account for new information and developments.

Figure 1: Climate Change Adaptation and Resilience Planning Process



STEP 1: DEFINE CONTEXT

Defining the context for climate change adaptation and resilience action planning in Canmore involves:

- **Defining the spatial scope**

  The spatial scope was limited to impacts within the Bow Valley Corridor encompassing the Town of Banff and the Town of Canmore, and potential actions within the municipal boundaries of the Town of Canmore only.[1] Consideration was also given to external effects that impact the Towns, such as tourists originating from outside the region, and infrastructure that links the communities to elsewhere (e.g. roads, power lines, etc.).

- **Defining the operational scope**

  The assessment of risks and opportunities considered potential community-wide impacts, which included impacts to municipal infrastructure, property and services, as well as impacts to private property, the local economy, the health and lifestyle of residents, and the natural environment.

- **Defining the temporal scope**

  The assessment considered impacts arising from projected climate and associated environmental changes to the 2050s, the 30-year period from 2040 to 2069. This timeframe looks ahead to the types of changes and challenges, which decision-makers and residents might face within their lifetimes. It also reflects a planning horizon that, although long in political terms, lies within the productive life of key public infrastructure investments and strategic land-use planning and development decisions.

- **Compiling climate and impact data**

  Climate projections for the 2050s were compiled for the Bow Valley Corridor, and historical weather data was analyzed to identify observed trends in key climate variables. Information was also compiled on the main projected environmental changes for the area by the 2050s. This activity is discussed further in Section 3.

[1] Note that the identification of potential climate-related impacts involved stakeholders from both the Town of Banff and the Town of Canmore; hence the wider spatial scope. However, both the determination of priority risks and opportunities and the formulation of actions to address those priorities was performed by stakeholders from the Town of Canmore only, focusing solely on Canmore.

- **Developing scales to score risks and opportunities**

  Scales are required to establish the relative magnitude and likelihood of impacts in order to define priorities for action. The scales used in the risk and opportunity assessment are provided in Appendices to the report.

STEP 2: ASSESS RISKS AND OPPORTUNITIES

Step 2 of the planning process occurred in two stages.

First, a half-day workshop was held in conjunction with the Town of Banff on November 17th, 2015, during which stakeholders from Canmore participated in the three sessions outlined below. This workshop was part of the Climate Resilience Express project.

- **Session 1: Exploring local weather and impacts**

  This session explored the relationship between weather, climate and key aspects of Banff and Canmore in relation to past weather related impacts. Outcomes from this session at the workshop are presented in Box 1 in Section 3.

- **Session 2: Introduction to climate science and impacts**

  Information about climate science, local climate trends and projections, environmental changes, and potential impacts for the area were compiled and presented by Dr. Mel Reasoner. Local climate trends, climate projections, and projected future environmental changes for the Bow Valley Corridor are presented in Section 3.

- **Session 3: Identifying future climate impacts**

  The focus of this session was to determine how projected climate or environmental change could impact the Bow Valley Corridor. Outcomes from this session at the workshop are presented in Section 4.

Second, a half-day climate risk and opportunity assessment workshop was held with Town of Canmore stakeholders on November 18th, 2015. The objective of this workshop was (a) to affirm the relevance to Canmore of the climate impacts identified the previous day and (b) to prioritize the relevant impacts in order to establish priorities for action planning. As Session 3 generated a list of impacts pertaining to the Bow Valley Corridor, it was first necessary to review and modify the list, retaining only those impacts specifically relevant to Canmore. Outcomes from this session at the workshop are presented in Section 5.

STEP 3: FORMULATE ACTIONS

Step 3 focused on determining what actions are necessary to increase resilience to priority risks and to capitalize on priority opportunities. "Action planning" was completed through structured stakeholder meetings focused on priority risks and opportunities facing specific departments or groups of stakeholders. Five meetings were held with Town of Canmore Staff and key external stakeholders from March 7th through 9th, 2016. Meeting participants brainstormed candidate actions to address each priority risk and opportunity pertinent to their area of responsibility. This involved answering the following questions:

- ✓ What is the Town currently doing to address the risk or manage the potential opportunity?
- ✓ Should current actions be improved given what you learned about projected climate change? If so, how?
- ✓ What additional action(s) is needed to provide an acceptable level of risk or opportunity management?

Given the reality of scarce financial and human resources, it is nearly always necessary to refine or prioritize the full-list of candidate actions, and to identify a preferred action or package of actions, that could be implemented as priorities and resources allow. To help decision-makers at the Town of Canmore establish priorities going forward, each of the actions identified at the stakeholder meetings was (a) characterized and (b) evaluated against a set of criteria commonly used to prioritize adaptation actions. Outcomes of the action planning step are presented in Section 6.

STEP 4: IMPLEMENT, REVIEW AND UPDATE PLAN

Outcomes from Steps 1 through 3 form the basis for Canmore's Climate Change Adaptation and Resilience Plan. Building resilience and adapting to climate change is not a static process, but rather needs to be monitored and reviewed to check progress on implementation and take account of changing scientific knowledge about the physical impacts of climate change. Implementing the Plan, reviewing progress, and updating it to keep it relevant are discussed in Section 7.

Representatives from the Town of Canmore and key community stakeholders who participated at the workshops and supported the development of this report are listed in Appendix A.

3. Observed Impacts, Climate Trends and Projections

Observed Local Weather and Climate Impacts

Session 1 at the workshop on November 17th, 2015 invited participants to identify how the Bow Valley Corridor has been affected by weather-related events in the recent past, considering impacts on the local economy, property and infrastructure, the natural environment, and resident's health and lifestyles. A selection of observed weather-related impacts identified by participants is provided in Box 1.

Box 1: Summary of Observed Weather Events and Impacts

- ✓ Fire events in 2003 and 2006 affected tourism visitation and caused local health impacts from smoke
- ✓ High wind events have caused tree blow down and infrastructure damage
- ✓ Major flood events, notably 2013, caused significant community-wide impacts
- ✓ Warmer winters with less snow impact ski areas and dog sledding
- ✓ Freeze-thaw cycles negatively impact roads and sidewalks and have led to transportation disruptions
- ✓ Wildlife habitat and migration patterns are impacted by long-term changes in temperature
- ✓ The tourism season is extending longer into the fall
- ✓ Reduced river flows increase stream temperatures and affect water supply and recreation
- ✓ Pest infestations such as mountain pine beetle are apparent
- ✓ There appears to be more ticks and a longer tick season
- ✓ The allergy season appears to be longer and different
- ✓ Reduced snowpack over the winter season
- ✓ Glacier recession on icefields is noticeable
- ✓ Excessive precipitation in short duration overwhelms the stormwater system
- ✓ More extreme weather is apparent – heat, wind, hail, thunderstorms
- ✓ Longer growing seasons for community gardens

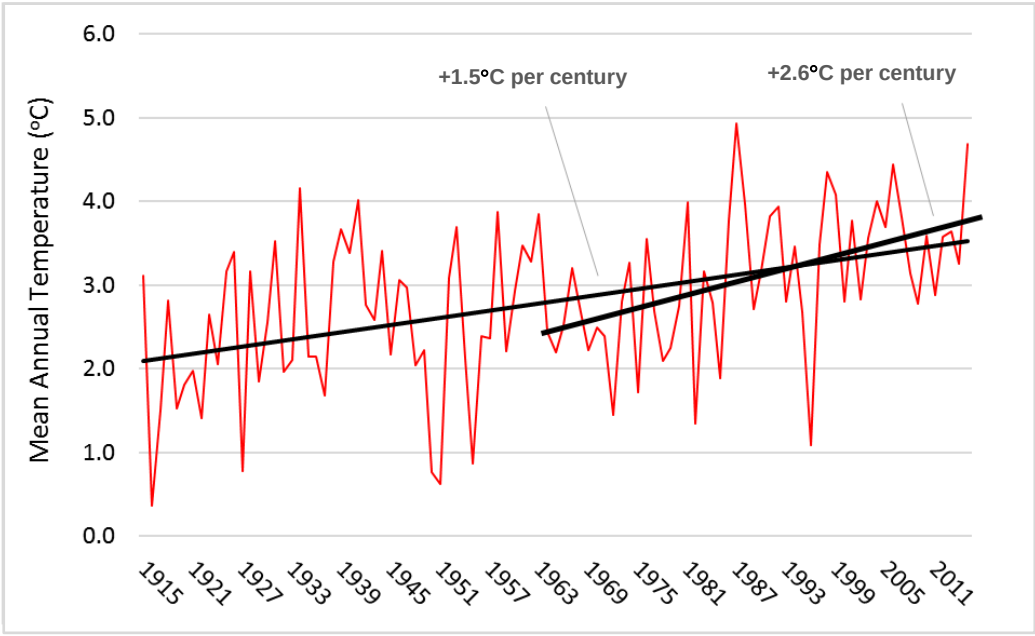
LOCAL CLIMATE TRENDS

To provide a perspective of historic climate trends in the Bow Valley Corridor, data was collected and analyzed from six climate stations in the region (Golden, Lake Louise, Banff, Kananaskis, Calgary and Olds) [2]. These climate stations were selected because the data cover multiple decades, are high quality, and the stations span an area that is comparable to the same area for which climate projections are available. Climate records (e.g. temperature, precipitation, growing degree days, etc.) for the Bow Valley Corridor were assembled by averaging the individual records from the five climate stations.

Temperature records

Temperature records for the area over the period 1915-2015 show that mean annual temperature has increased at a rate of +1.5°C per century (Figure 2), which is approximately 1.7 times faster than the observed global rate of warming over the same time period. The rate of warming observed over the last 50 years is higher still at +2.6°C per century.

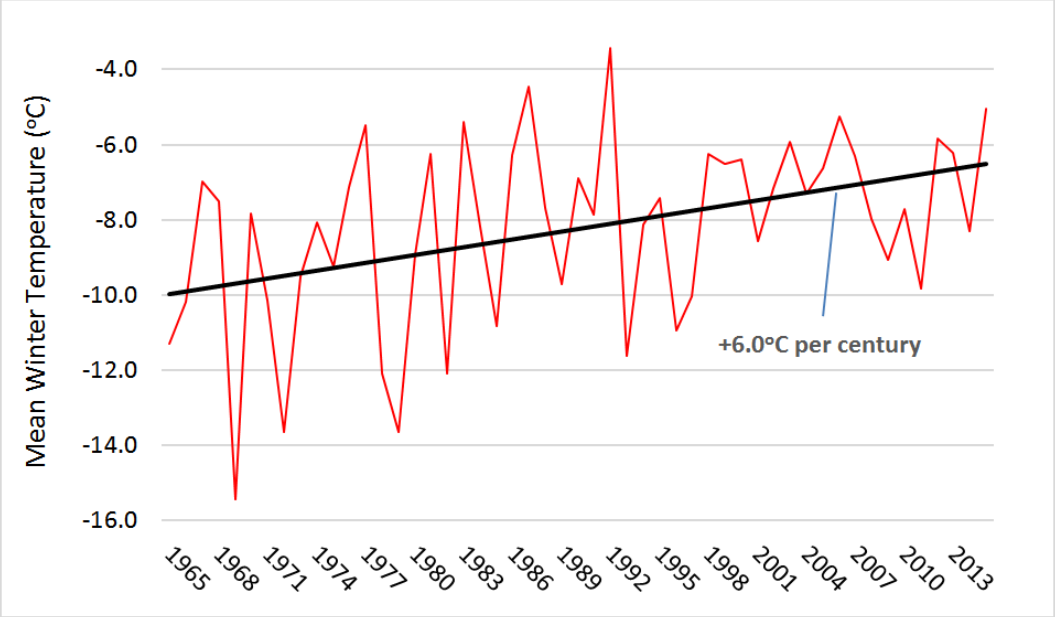
Figure 2: Mean Annual Temperature in the Bow Valley Corridor (1915-2015)



[2] Environment Canada's Adjusted and Homogenized Canadian Climate Data (AHCCD) are quality controlled climate data that incorporate a number of adjustments applied to the original meteorological station data to addresses any inaccuracies introduced by changes in instruments and observing procedures. The AHCCD stations (Golden, Banff, Calgary and Olds) were supplemented with additional data from the Kananaskis (Environment Canada) and Lake Louise (Environment Canada and AgroClimate Information Service, Government of Alberta).

Over the last 50 years, the largest seasonal increase in temperature in the Bow Valley Corridor occurred during the winter (December-February). The observed rate of warming in winter since 1965 is +6.0°C per century (Figure 3). In contrast, warming during the summer (June-August) since 1965 occurred at a slower rate of +1.9°C per century. Trends in mean spring and fall temperature are also positive, but the rate of warming in these seasons over the last 50 years is less pronounced.

Figure 3: Mean Winter Temperature in the Bow Valley Corridor (1965-2015)



Precipitation records

Mean annual precipitation in the Bow Valley Corridor has not changed much over the last century. Further, changes in seasonal precipitation since 1915 and since 1965 show no significant trends with one exception; winter precipitation has decreased at a rates of -35mm per century over the last 100 years and -88mm per century over the last 50 years (Figure 4).

Also, since 1965, the amount of precipitation falling as snow has been declining at a rate of -122 mm per century (Figure 5), which is consistent with the observed warming in the region over this time frame.

Figure 4: Mean Winter Precipitation in the Bow Valley Corridor (1915-2015)

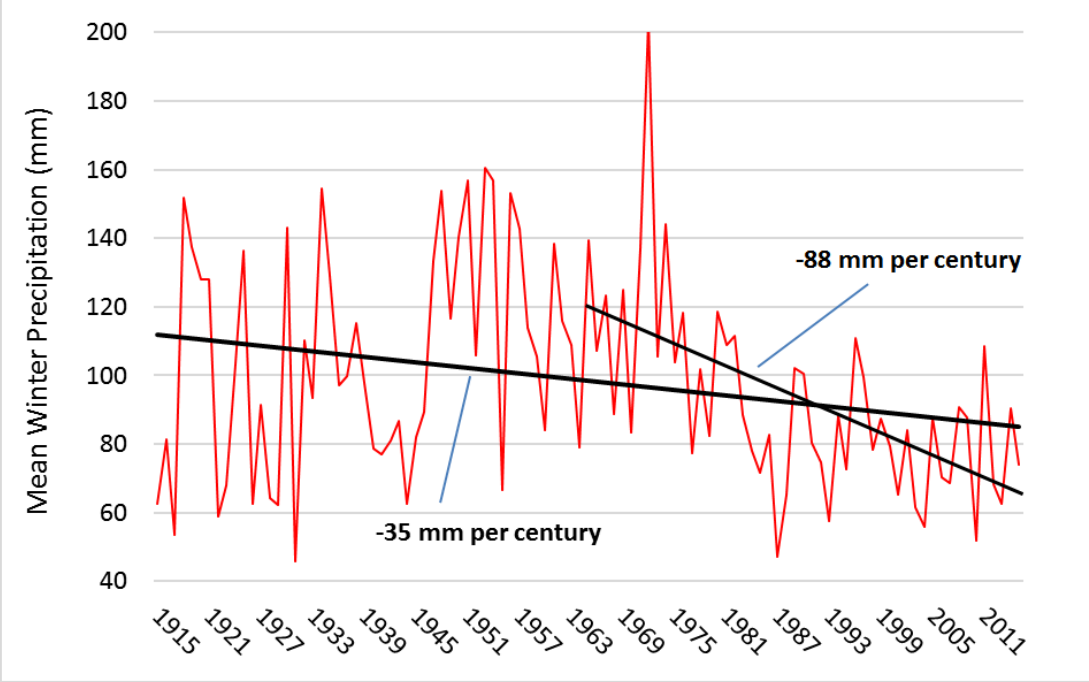
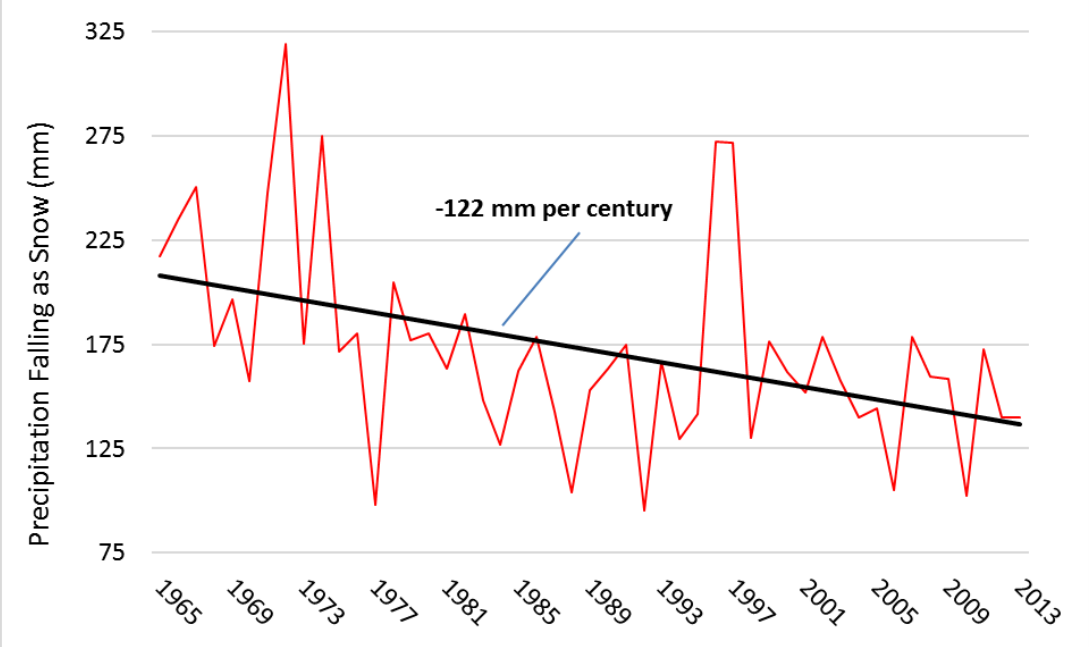


Figure 5: Mean Annual Precipitation Falling as Snow (1965-2015)



CLIMATE PROJECTIONS FOR THE BOW VALLEY

Climate projections for the Bow Valley Corridor, for the 2050s, were derived using the Pacific Climate Impacts Consortium's (PCIC) Regional Analysis Tool[3]. The projections are based on results from 15 different Global Climate Models (GCMs). Each model generates output for one high and one low GHG emission scenario. Projected climate change within the models is primarily driven by assumed increases in concentrations of GHGs in the atmosphere. The results from all 15 GCMs for both GHG emission scenarios are averaged.

> "Since the mid-20th century human activities, including the burning of fossil fuels and changes in land use patterns have been the dominant cause of climate change… This trend is expected to continue through the present century and beyond, leading to rates of global warming that will exceed any experienced during the past several thousand years." [4]

Climate projections for the 2050s in the Bow Valley Corridor area are summarized in Table 1. The mean annual temperature is anticipated to increase by +1.9°C above the 1961-1990 baseline, which will increase the absolute mean annual temperature to about +4.7°C. This projected increase in temperature is consistent with the rate of change in mean annual temperature that has been observed in the Bow Valley Corridor over the last 50 years. The projected increase in mean annual temperature is expected to be accompanied by an increase in mean annual precipitation of approximately 5%.

The projected increases in mean summer temperatures (+2.2°C) exceed the mean annual projection, and it is anticipated that this increase in summer temperature will be accompanied by a decline in summer precipitation of precipitation of 5%. Mean winter temperature is expected to increase by +1.9°C with a 9% increase in mean winter precipitation. Mean temperatures are expected to rise less dramatically in the spring and fall (+1.5°C and +1.8°C, respectively); precipitation is projected to increase by 9% in both the spring and fall.

[3] The Pacific Climate Impacts Consortium (PCIC) is a regional climate service centre based at the University of Victoria. PCIC provides a number of tools that support long-term planning for climate change including the model projections derived from the Regional Analysis Tool.

[4] Warren, F.J. and Lemmen, D.S., editors (2014): Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation; Government of Canada, Ottawa, ON, 286p.

Table 1: Summary of Climate Projections the Bow Valley Corridor by the 2050s

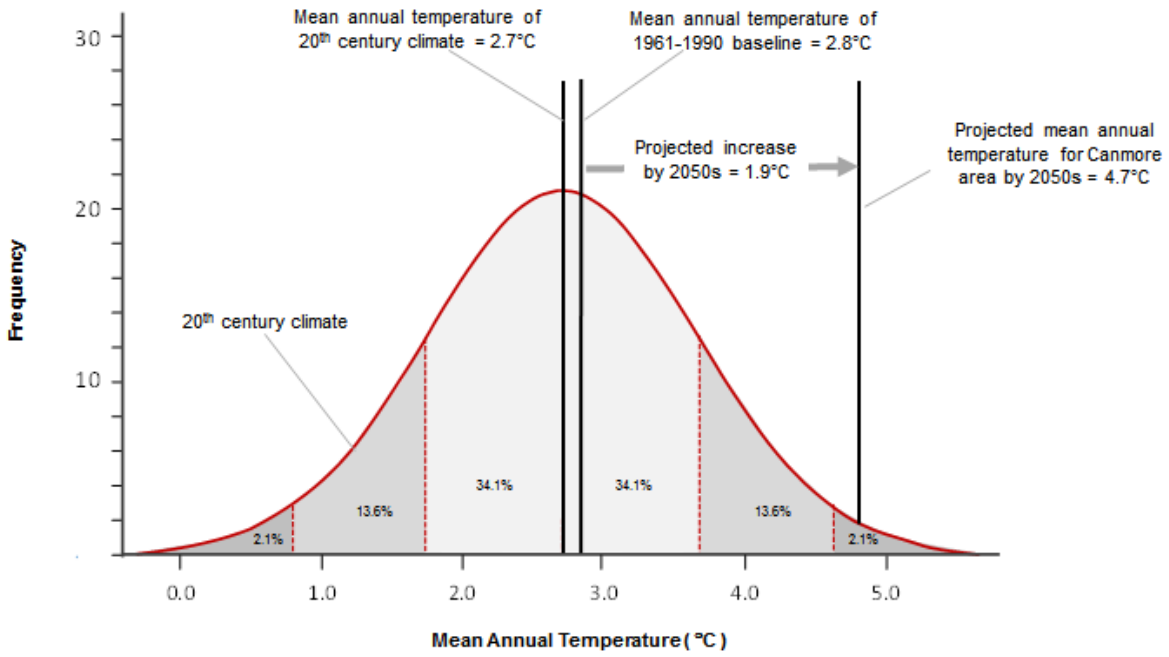
Climate Variable	Season	Baseline (1961-1990)	Projected Change	
			Mean	Range
Average temperature	Annual	+2.8°C	+1.9°C	(+1.2 to +2.8)
Average precipitation	Annual	536mm	+5%	(-2% to +11%)
Average temperature	Summer	14.0°C	+2.2°C	(+1.5 to +3.1)
Average precipitation	Summer	194mm	-5%	(-17% to +7%)
Average temperature	Winter	-8.8°C	+1.9°C	(+1.1 to +3.3)
Average precipitation	Winter	105mm	+9%	(-2% to +17%)
Average temperature	Spring	2.9°C	+1.5°C	(+1.0 to +2.5)
Average precipitation	Spring	120mm	+9%	(+3% to +20%)
Average temperature	Fall	3.3°C	+1.8°C	(+1.2 to +2.6)
Average precipitation	Fall	117mm	+9%	(-2% to +14%)

Notes: The mean projected change is the average value over the 30-year period 2040-2069. The range is defined by the 10th and 90th percentile values. Summer includes Jun-Aug, fall includes Sep-Nov, winter includes Dec-Feb, and spring includes Mar-May.

Box 2: Putting Projected Changes in Mean Annual Temperature in Context

In order to place the magnitude of the projected temperature changes in the 2050s into context, the 20th century climate of the Bow Valley Corridor (1914-1999) was fitted to a normal distribution (bell curve). The mean of the probability distribution is then shifted by the projected temperature increase of +1.9°C above the 1961-1990 baseline. This increase in mean annual temperature represents a shift of more than two standard deviations above the 20th century mean temperature. In other words, the climate projections indicate that the mean annual temperature of the 2050s in the Bow Valley Corridor will be similar to the warmest 2% of 20th century climate.

Although a change in mean annual temperature of +1.9°C may not appear to be a large absolute shift in climate, when compared with the probability distribution of 20th century climate in the Bow Valley Corridor, a shift of this magnitude is substantial. By analogy, the projected shift in mean annual temperature will be similar to replacing the mean annual temperature in the Bow Valley Corridor over the period 1961-1990 with that of a prairie town like Brooks, two hours drive SE of Calgary.



Precipitation extremes

In recent years, numerous extreme precipitation events have occurred at various locations globally at monthly, daily and sub-daily timescales; several have occurred in western Canada with serious consequences. Recent studies have demonstrated that extreme rainfall intensity increases by about 7% for every degree increase in global atmospheric temperature[5]. Model projections of short-duration precipitation is an emerging area of research and presents challenges due to—among other things—difficulties in modelling convective storms and the limited availability of hourly climate data for establishing long-term trends. However, as global temperatures increase, the capacity of the atmosphere to carry water vapor also increases. This will supply storms of all scales with increased moisture and produce more intense precipitation events[6]. Consequently, it is very likely that the Bow Valley Corridor will see more extreme precipitation events as the climate continues to warm in the coming decades.

PROJECTED ENVIRONMENTAL CHANGES

Projected changes in average temperature and precipitation for the Bow Valley Corridor will have broad consequences across the natural environment, including for the extent of glaciers, winter snowpack, streamflow, wildfires and forest pests, and regional ecosystems[7].

Glaciers

Glaciers in the Rocky Mountains are an important water resource in Alberta, providing a vital component of surface water flows to drainages east of the Rockies, especially during the summer months.[8] Over the course of twenty years, between 1985 and 2005, glaciers in Alberta lost approximately 25% of their area (e.g., Figure 6). [9] Projections of continued warming combined with projections of reduced winter precipitation falling as snow are projected to result in an approximate 50% additional decline in ice area in the Canadian Rockies between 2005 and the middle of the century (Figure 7). [10]

[5] Westra, S., Alexander, L.V., Zwiers, F., 2013. Global increasing trends in annual maximum daily precipitation. J Clim 26(11) 3904–3918.

[6] Trenberth, K.E., 2011. Changes in precipitation with climate change. Clim Res., 47, 123-138.

[7] This information compiled with support from the Alberta Biodiversity Monitoring Institute and results of the Biodiversity Management and Climate Change Adaptation project.

[8] Demuth M.N. and A. Pietroniro. 2003. The impact of climate change on the glaciers of the Canadian Rocky Mountain eastern slopes and implications for water resource-related adaptation in the Canadian prairies: headwaters of the North Saskatchewan River basin. Prairie Adaptation Research Collaborative, Regina SK, Project P55. Available at http://www.parc.ca/

[9] Bolch, T., B. Menounos, and R. Wheate. 2010. Landsat-based inventory of glaciers in western Canada, 1985-2005. Remote Sensing of Environment 114:127-137.

[10] Clarke, G.K.C., A.H. Jarosch, F.S. Anslow, V. Radić, and B. Menounos. 2015. Projected deglaciation of western Canada in the twenty-first century. Nature Geoscience 8:372-377.

Figure 6: A Century of Change in the Robson Glacier: 1911 to 2011

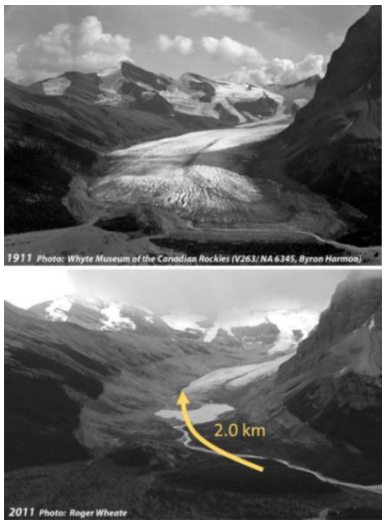
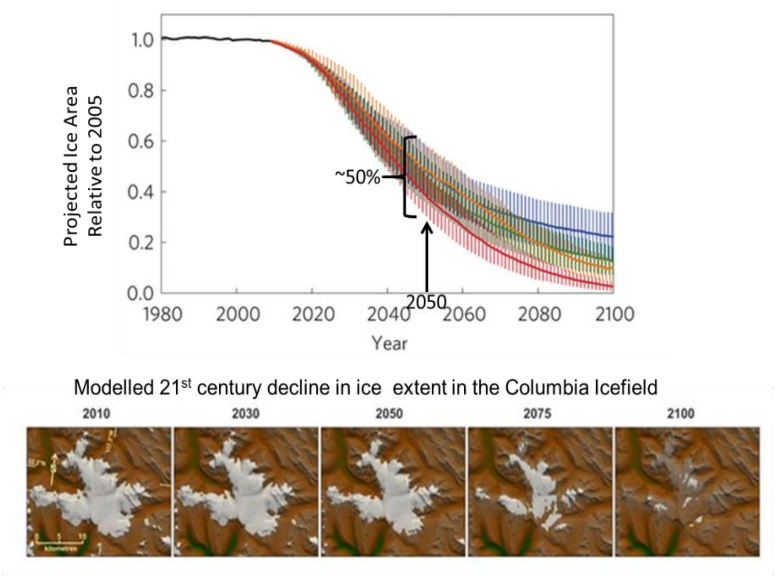


Figure 7: Projected Glacier Ice Area in the Canadian Rockies Over the 21st Century Relative to the Glacier Ice Area in 2005 Under Range of Climate Scenarios[11]

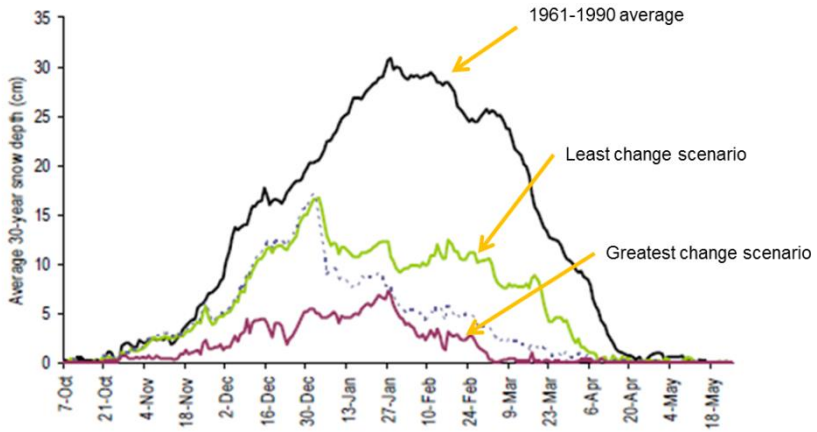


[11] From Clarke, G.K.C., A.H. Jarosch, F.S. Anslow, V. Radić, and B. Menounos. 2015. Projected deglaciation of western Canada in the twenty-first century. Nature Geoscience 8:372-377. The modeled extent of ice in the Columbia Icefield presented in the images is based on the high global carbon emissions scenario: RCP 8.5.

Snowpack

The projected winter and spring warming and reduced precipitation falling as snow in the winter months will affect the snowpack in the Rocky Mountains.[12,13] In the Bow Valley Corridor, average daily snow depth at 1,600m elevation is projected to decline by up to 50% by the middle of the century (Figure 8), although smaller declines are projected for higher elevations.[14]

Figure 8: Projected Daily Average Snow Depth at Banff (1600m Elevation) in the 2050s under Range of Climate Scenarios[15]



Streamflow

Streamflow volume and timing in the rivers and creeks on the eastern slopes of the Canadian Rockies depend on both snowmelt runoff and glacial meltwater, in addition to groundwater.[16] Warmer winter temperatures, an increased proportion of rain versus snow in winter months, and

[12] Lapp, S. J. Byrne, I. Townshend, and S. Kienzle. 2005. Climate warming impacts on snowpack accumulation in an alpine watershed. International Journal of Climatology 25:521-536.

[13] Pederson, G.T., J.L. Betancourt, and G.J. McCabe. 2013. Regional patterns and proximal causes of the recent snowpack decline in the Rocky Mountains, U.S. Geophysical Research Letters 40:1811-1816.

[14] Scott, D. and B. Jones. 2005. Climate Change & Banff National Park: Implications for Tourism and Recreation. Report prepared for the Town of Banff. Waterloo, ON: University of Waterloo.

[15] From Scott, D. and B. Jones. 2005. Climate Change & Banff National Park: Implications for Tourism and Recreation. Report prepared for the Town of Banff. Waterloo, ON: University of Waterloo.

[16] Byrne, J.M., D. Fagre, R. MacDonald, and C.C. Muhlfeld. Climate Change in the Rocky Mountains. *In:* Impact of Global Changes on Mountains: Responses and Adaptation. Grover, V.I., A. Borsdorf, J.H. Breuste, P.C. Tiwari, and F.W. Frangetto eds. CRC Press, New York, NY.

earlier snowmelt will all influence streamflow in the rivers and creeks in the region.[17] Streamflow is projected to increase in winter, peak earlier in the spring, and decrease in the summer.[18] Meltwater from glacial sources will become increasingly less reliable in the future as glaciers in the eastern Rockies continue to melt.[19] Stream temperatures in the region are projected to increase during the summer months, as a result of projected warming, with potential consequences for aquatic wildlife habitats and recreation opportunities. [20,21]

Wildfires and Forest Pests

The warmer and drier climate projected for the Bow Valley Corridor by the 2050s will create conditions more favourable for wildfires. In particular, a longer fire season with more severe fire weather conditions in the future is likely to result in fires that are more difficult to control and to an increase in the average area burned.[22,23]

Climate change will also likely favour insect pests, like mountain pine beetle, whose populations will benefit from warming conditions that increase overwinter survival and promote faster generation times. [24,25]

[17] Sauchyn, D. J. St. Jacques, E. Barrow, S. Lapp, C.P. Valdivia, and J. Vanstone. 2012. Variability and trend in Alberta climate and streamflow with a focus on the North Saskatchewan River Basin. Final Report for the Prairies Regional Adaptation Collaborative. Regina, SK. Available at http://www.parc.ca/

[18] Ibid.

[19] Demuth M.N. and A. Pietroniro. 2003. The impact of climate change on the glaciers of the Canadian Rocky Mountain eastern slopes and implications for water resource-related adaptation in the Canadian prairies: headwaters of the North Saskatchewan River basin. Prairie Adaptation Research Collaborative, Regina SK, Project P55. Available at http://www.parc.ca/

[20] MacDonald, R.J., S. Boon, J.M. Byrne, M.D. Robinson, and J.B. Rasmussen. Potential future climate effects on mountain hydrology, stream temperature, and native salmonid life history. Canadian Journal of Fisheries and Aquatic Sciences 71:189-202.

[21] Byrne, J.M., D. Fagre, R. MacDonald, and C.C. Muhlfeld. Climate Change in the Rocky Mountains. *In:* Impact of Global Changes on Mountains: Responses and Adaptation. Grover, V.I., A. Borsdorf, J.H. Breuste, P.C. Tiwari, and F.W. Frangetto eds. CRC Press, New York, NY.

[22] de Groot, W.J., M.D. Flannigan, and A.S. Cantin. 2013. Climate change impacts on future boreal fire regimes. *Forest Ecology and Management* 294:35-44.

[23] Flannigan, M.D., M.A. Krawchuk, W.J. de Groot, B.M. Wotton, and L.M. Gowman. 2009. Implications of changing climate for global wildland fire. *International Journal of Wildland Fire* 18:483-507.

[24] Sambaraju, K.R., A.L. Carroll, J. Zhu, K. Stahl, R.D. Moore, and B.H. Aukema. Climate change could later the distribution of mountain pine beetle outbreaks in western Canada. Ecography 35:211-223.

[25] Byrne, J.M., D. Fagre, R. MacDonald, and C.C. Muhlfeld. Climate Change in the Rocky Mountains. *In:* Impact of Global Changes on Mountains: Responses and Adaptation. Grover, V.I., A. Borsdorf, J.H. Breuste, P.C. Tiwari, and F.W. Frangetto eds. CRC Press, New York, NY.

Regional Ecosystems

Alberta's natural sub-regions, which are defined by unique combinations of vegetation, soil and landscape features, represent the diversity of ecosystems in the province. The Town of Canmore and the Bow Valley Corridor currently occupy the Montane ecosystem: a mix of grasslands and deciduous-coniferous forests on south and west-facing slopes and valley bottoms, and coniferous forests on north-facing slopes and at higher elevations. [26] At higher elevations, the Montane ecosystem transitions to the Subalpine ecosystem, with open stands of coniferous forest, then to the Alpine ecosystem, where vegetation is primarily limited to low-growing forbs and grasses constrained to sheltered areas and meadows with rich soil (see Figure 9). [27]

The warmer and drier conditions projected for the Canmore area will have consequences for these regional ecosystems. The projected climate for the 2050s will be more favourable for grassland ecosystems at lower elevations in the valley bottoms and on south- and west-facing slopes (as shown in Figure 9). [28] In addition, the warming conditions will favour the expansion of lower-elevation forested ecosystems upslope at the expense of the alpine ecosystem, as trees are increasingly able to establish and grow at higher elevations. [29] These ecosystem changes will have consequences for the wide variety of wildlife species that occupy the Bow Valley corridor and the surrounding subalpine and alpine habitats, including habitat loss, range shifts, and changes to migration patterns and timing. [30]

[26] Natural Regions Committee. 2006. Natural Regions and Subregions of Alberta. Pub. No. T/852. Government of Alberta, Edmonton, Alberta. 264pp.

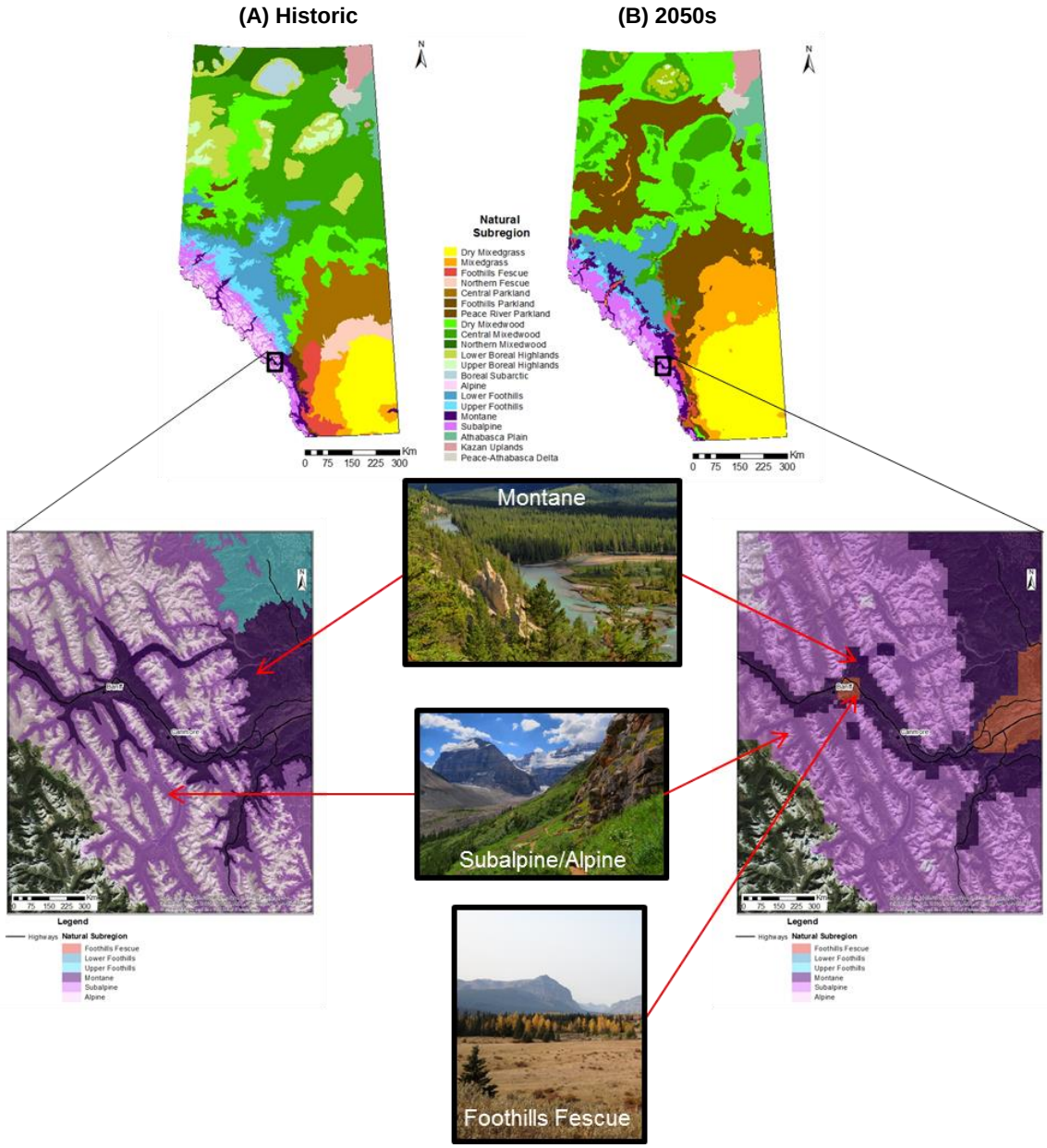
[27] Ibid.

[28] Schneider, R.R. 2013. Alberta's Natural Subregions under a changing climate: past, present and future. Biodiversity Management and Climate Change Adaptation Project, Alberta Biodiversity Monitoring Institute, Edmonton, AB. Available at: http://www.biodiversityandclimate.abmi.ca

[29] Byrne, J.M., D. Fagre, R. MacDonald, and C.C. Muhlfeld. Climate Change in the Rocky Mountains. *In:* Impact of Global Changes on Mountains: Responses and Adaptation. Grover, V.I., A. Borsdorf, J.H. Breuste, P.C. Tiwari, and F.W. Frangetto eds. CRC Press, New York, NY.

[30] Ibid.

Figure 9: (A) Historic (1961-1990) and (B) Projected (2050s) Distribution of Natural Sub-regions in Alberta and in the Bow Valley Corridor[31]



[31] Maps created with data available at http://www.biodiversityandclimate.abmi.ca. The mid-century Natural Sub-region projection from Schneider (2013) is based on the German ECHAM 5 global climate model and the A2 emissions scenario (IPCC, 2000): Schneider, R.R. 2013. Alberta's Natural Subregions under a changing climate: past, present and future. Biodiversity Management and Climate Change Adaptation Project, Alberta Biodiversity Monitoring Institute, Edmonton, AB. (Available at: http://www.biodiversityandclimate.abmi.ca/); and IPCC. 2000. Special Report on Emissions Scenarios - Summary for Policy Makers. Intergovernmental Panel on Climate Change Working Group III. Photo credits (top to bottom): Janine Rietz, Janine Rietz, and Emily Chow.

4. Potential Climate Change Impacts for the Bow Valley Corridor

Table 2 provides a summary of how the Bow Valley Corridor might be affected by projected climate and environmental changes. The listed impacts were developed by participants from both the Town of Banff and the Town of Canmore at the half-day workshop on November 17th, 2015. Impacts can have either mainly positive (**+**) or mainly negative (**-**) consequences for the local economy, property and infrastructure, the natural environment, and resident's health and lifestyles. The impacts in Table 2 were subsequently modified by representatives from Canmore at the workshop on November 18th, 2015, to arrive at a list of impacts deemed most relevant to the Town.

Table 2: Potential Climate Change Impacts with Mainly Negative (-) or Positive (+) Consequences for the Bow Valley Corridor

✓ Stormwater system overwhelmed, localized flooding (-)	✓ Adverse impacts on fish and aquatic ecosystem from changes in stream flow timing and volume (-)
✓ Increased avalanche risk (-)	✓ Decline in winter tourism and recreation (-)
✓ Hail storm (-)	✓ Reduction in glacier-based tourism (-)
✓ Lightning (-)	✓ Heat stress on vulnerable populations (-)
✓ More wildfires (-)	✓ Increase water demand (-)
✓ River flooding (-)	✓ Increased health impacts from lack of exercise (-)
✓ Creek flooding (-)	✓ Reduction in snow clearing (+)
✓ Water supply shortage (-)	✓ Increase in summer tourism / shoulder season, including walking and biking (+)
✓ Increased sediment loading – turbidity (-)	✓ Increase in home gardening opportunities (+)
✓ Frost penetration – damaged water lines (-)	✓ Extended construction season (+)
✓ Extreme wind (-)	✓ Reduced road maintenance costs (+)

5. Climate Change Risk and Opportunity Assessment

Climate change risks and opportunities were assessed using a structured risk assessment methodology, which included three key steps:

1: **Identification**: Determine how projected future climate or environmental changes could impact Canmore, both positively and negatively.

2: **Analysis**: Assign a score to each identified impact, based on local perceptions of the magnitude of potential consequences and the likelihood of those consequences occurring. The scores are used to generate a risk and opportunity matrix—a two dimensional representation of consequences plotted against likelihood (see Figure 11).

3: **Evaluation**: Review the relative position of impacts in the matrices with staff and local stakeholders, manually adjust their location if they are judged—when viewed collectively—to have been either over or under-estimated in comparison to one another, and identify priorities for action planning (see Section 6).

Each of these steps is further described below.

Step 1: Identification

The potential climate change impacts for the Bow Valley Corridor listed in Table 2 were reviewed by stakeholders from Canmore at the workshop on November 18th, in order to define those risks and opportunities most relevant to Canmore. Potential impacts relevant to Canmore, which were not identified at the workshop in Banff on November 17th, were added to the list. At the same time, impacts in Table 2 deemed not relevant to Canmore were removed.

For each climate impact we developed an impact statement characterizing the specific consequences of the risk or opportunity for Canmore. The impact statements, along with the detailed outcomes of the risk and opportunity assessment, are provided Appendix B.

Step 2: Analysis

Taking each climate-related impact in turn, workshop participants rated (scored) both the consequence for Canmore and the associated likelihood of occurrence. The process was undertaken using digital voting software, which displays the outcomes in real-time and thus facilitates discussion. Each impact is scored, the results are presented, and then discussed. Depending on the discussion—for instance, if there is large variability across the recorded

scores and strong arguments are presented that convince participants to modify their original scores—participants may opt to re-vote on the consequence and likelihood scores.

Participants rated the consequences and likelihood of impacts using the scales at Appendices C, D and E.

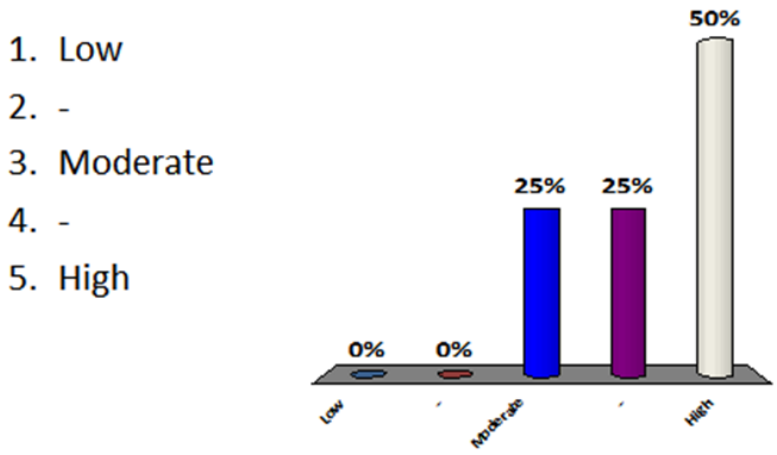


Figure 10: Example of Output from Digital Voting Software

STEP 3: EVALUATION

The risk and opportunity matrices constructed during the analysis step were subsequently evaluated to arrive at priorities for action planning. This was accomplished in two stages:

First, both matrices were divided into different (coloured) zones, with each zone defining a particular course of action. The consequence and likelihood scores assigned to an impact determine the zone it falls under within in the matrix, and this in turn defines its priority for action planning.

Second, in light of the initial priority assigned impacts, the relative position of impacts within the matrices was reviewed by workshop participants, and the location of specific impacts adjusted if they were judged—when viewed collectively—to have been either over- or under-estimated in comparison to all other impacts.

The evaluation step was performed after the workshop on November 18th, 2015; participants were provided with the outputs of the analysis step, a set of questions to consider, and invited to suggest amendments to the original results.

The following amendments were suggested and made to likelihood and consequence scores for climate change risks facing the Town of Canmore:

- ✓ Forest fire moved up from moderate-high consequences to high consequences. Forest fires have potential to cause major, widespread damage, including health and quality of life impacts;
- ✓ River flooding moved up from moderate-high consequences to high consequences, and right from low-moderate likelihood to moderate likelihood. Major flooding on the Bow River could impact a very large population base and damage critical infrastructure;
- ✓ Creek flooding moved right from low-moderate likelihood to moderate likelihood. Given the experience of Canmore in 2013, and elsewhere in the world, along with the projected increase in extreme precipitation events, creek flooding with moderate-high consequences was seen as an event that would occur every 5 to 10 years;
- ✓ Heat stress on vulnerable populations moved down from moderate consequences to low-moderate consequences. Given Canmore's current climate and capacity to manage heat extremes now, future heat stress was not seen as a risk that would have consequences similar to other moderate consequence risks; and
- ✓ Avalanche risk moved down from low-moderate consequences to low consequences. Avalanches tend to affect only a small proportion of the economy and are managed effectively with minimal expense to the Town of Canmore in comparison to some of the other risks.

Changes to the types of plant species that are able to grow in the Bow Valley Corridor, including the introduction of invasive species, was raised as a potential threat to the local ecosystem, with consequences for native species, soils, canopy, understory and the water table. However, the risk associated with invasive species taking root in the Corridor as climate change creates more hospitable conditions, was not assessed. Invasive species should be included within the scope of future iterations of Canmore's climate change adaptation and resilience plan.

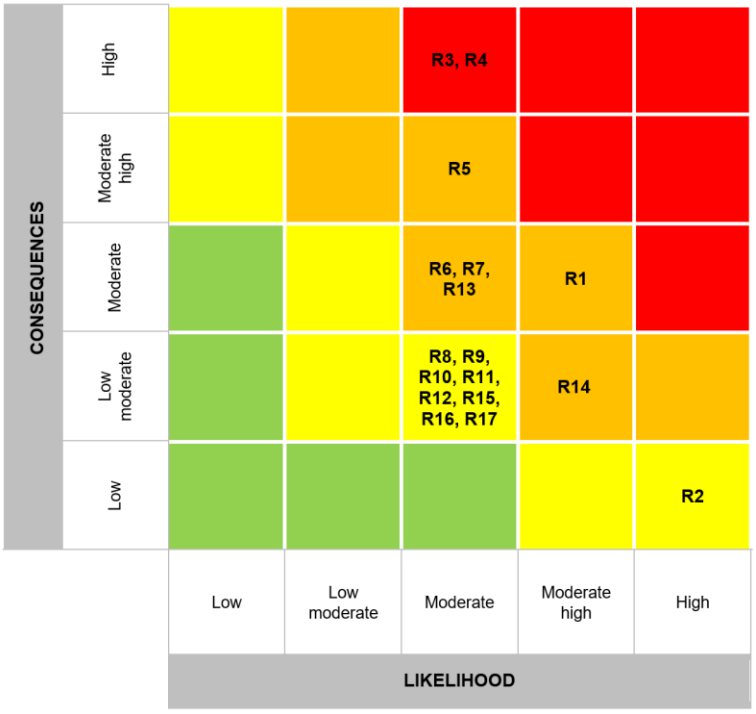
The finalized climate risk matrix is provided in Figure 11.

The following amendments were suggested and made to likelihood and consequence scores for climate change opportunities facing the Town of Canmore:

- ✓ Extended construction season moved up from low-moderate consequences to moderate consequences. Warmer temperatures, particularly in fall and spring would allow construction projects to be undertaken both earlier and later in the season. The reduction in cost and potential avoidance of disruption during peak tourist season would have consequences similar to the other moderate opportunities.

The final opportunity matrix is provided below in Figure 12.

Figure 11: Canmore Climate Change Risk Rating Matrix



R1	Stormwater system overwhelmed, localized flooding	**R10**	Increased water demand
R2	Avalanche	**R11**	Decline in winter recreation opportunities
R3	Forest fire	**R12**	Adverse impacts on fish and aquatic ecosystems
R4	Bow River flooding	**R13**	Heavy snowfall, blizzard
R5	Creek flooding	**R14**	Freeze-thaw cycles
R6	Extreme wind	**R15**	Increased in human contact with wildlife
R7	Water supply shortage	**R16**	Increase in vector-borne diseases
R8	Sediment loading - turbidity	**R17**	Increase in invasive specifies
R9	Heat stress on vulnerable populations		

High priority
Further investigations and/or management actions must be developed as part of action planning.

Medium priority
Further investigations and/or management actions should be developed as part of action planning.

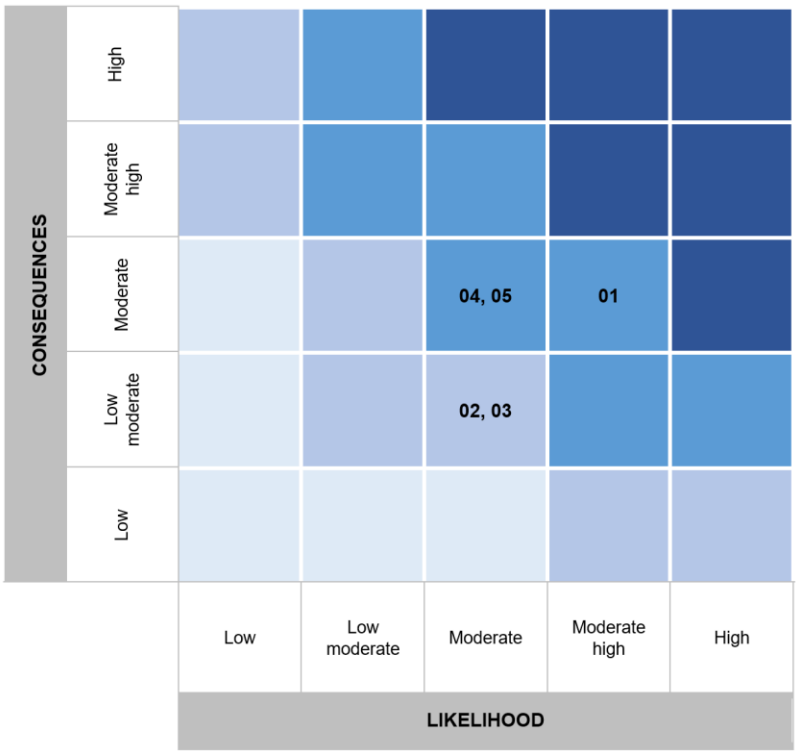
Priorities for action planning

Low priority
No action required beyond monitoring of the risk level and priority as part of regular reviews.

Acceptable Risk
Broadly acceptable risk. No action required beyond consideration as part of regular reviews.

Keep under review

Figure 12: Canmore Climate Change Opportunity Rating Matrix



O1	Increase in summer season recreation opportunities	**O4**	Extended construction season
O2	Increase in food growing opportunities	**O5**	Increase in winter tourism competitive advantage[32]
O3	Reduced heating demand		

High priority
Further investigations and/or management actions must be developed as part of action planning.

Medium priority
Further investigations and/or management actions should be developed as part of action planning.

Priorities for action planning

Low priority
No action required beyond monitoring of the opportunity level and priority as part of regular reviews.

Lowest priority
No action required at this time.

Keep under review

[32] Although the snow pack and snow fall within the Bow Valley Corridor is projected to decline through the 2050s, participants at the workshops believed the reductions would be less than those experienced at other winter sport and tourism destinations within North America (and the world), resulting in increased winter tourism for the Town of Canmore.

PRIORITIES FOR ACTION

The following eight risks were determined to be priorities for action planning:

High priority risks	
R3	Forest fire
R4	Bow river flooding
Medium priority risks	
R5	Creek flooding
R1	Stormwater system overwhelmed, localized flooding
R6	Extreme wind
R7	Water supply shortage
R13	Heavy snowfall event, blizzard
R14	Freeze-thaw cycles

The following three opportunities were determined to be priorities for action planning:

Medium priority opportunities	
O1	Increase in summer season recreation opportunities
O4	Extended construction season
O5	Increase in winter tourism competitive advantage

6. Actions to Address Priority Risks and Opportunities

Process of Formulating Actions

Step 3 in the Climate Change Adaptation and Resilience Planning Process (recall Figure 1) involves formulating a portfolio of preferred actions: (a) to increase resilience to priority risks and (b) to increase capacity to capitalize on priority opportunities.

A range of candidate actions were identified at a series of meetings with Town staff and other local stakeholders. Each meeting focused on one or more of the medium and high priority risks and opportunities plotted in Figure 11 and Figure 12, respectively.

The first activity at the meetings involved establishing resilience objectives for each priority risk or opportunity. For example, an objective for (R3) forest fires might be: to respond to, and recover from forest fires in a timely and efficient manner. Next, participants were invited to identify potential actions to achieve the stated objectives. To this end, participants were invited to address two questions:

- ✓ What actions are currently being taken to achieve the stated objective(s)?
- ✓ What additional actions or adjustments to existing policies, plans and operational procedures, etc. might be required to achieve the objective(s) in the future?

Participants were encouraged to think broadly, and to consider all categories of potential actions listed in Box 3.

Box 3: Broad Categories of Adaptation and Resilience Actions

Research and monitoring	Bylaws and plans
Early warning systems	Technologies
Hazard information provision	Infrastructure (hard and soft)
Awareness raising	Economic instruments
Operations and practices	

Given the reality of limited municipal (financial and human) resources, it is nearly always necessary to screen, rank and prioritize actions and identify a portfolio of 'preferred' actions. To support decision-makers in Canmore with prioritizing actions for implementation, the project team:

- ✓ Characterized the identified actions, in terms of: (1) investment costs; (2) annual recurring costs; (3) timeframe for implementation; and (4) implementation lead. These factors are key inputs to the development of an implementation strategy. Approximations for (1), (2) and (3) were based on Table 3.
- ✓ Evaluated the identified actions against a number of decision criteria commonly used to screen, rank, and prioritize climate adaptation and resilience actions; the criteria used are shown in Table 4. The results of the evaluation exercise are presented in Appendix G.

Table 3: Key Information to Support Decision-making During Implementation Planning

Criteria	1	2	3	4
Lead (department, stakeholder, or agency)	[state]			
Investment (implementation) costs	$ (< $50,000)	$$ ($50,000 - $99,999)	$$$ ($100,000 - $500,000)	$$$$ (> $500,000)
Annual (recurring) costs	$ (< $10,000)	$$ ($10,000 - $49,999)	$$$ ($50,000 - $100,000)	$$$$ (> $100,000)
Timeframe (to have action implemented by)	Short-term (< 3 years)	Medium -term (3-6 years)	Long-term (> 6 years)	Ongoing

Table 4: Evaluation Criteria for Prioritizing Actions

Criteria	Score			
	1	2	3	4
Effectiveness	Minor contribution to effective management of risk	←	→	Vital to effective management of risk and achievement of objectives
Affordability	Requires significant additional budget for implementation	←	→	Can be completed within planned budgets
Feasibility	Lack of human, legal, knowledge, technical or administrative capacity to implement	←	→	Sufficient human, legal, knowledge, technical and administrative capacity to implement
Acceptability	Significant pushback likely from specific stakeholders, elected officials	←	→	Supported by the majority of stakeholders, elected officials
Equitability	Has unintended or undesirable distributional effects	←	→	Costs and benefit equally shared across community
Flexibility	Difficult to reverse, inflexible	←	→	Easy to scale up or down, flexible, no-regret

ELEMENTS OF AN ACTION PLAN

In addition to information on the local planning context, climate trends and projections for the area, and associated risks and opportunities, a climate change adaptation and resilience plan will include an "Action Plan", which typically contains the following key elements:

- ✓ A vision statement;
- ✓ Strategic goals;
- ✓ Specific climate adaptation and resilience objectives;
- ✓ A list of priority actions; and
- ✓ Resource and timing issues.

Vision

The Action Plan usually includes a statement of what it is trying to accomplish, in terms of a vision for the future of Canmore given changing climate conditions. A vision statement also provides a means of communicating the aim and intended outcomes of the Action Plan. A simple vision statement for Canmore might read:

> The Town of Canmore is resilient to the threats of projected climate change, and prepared to take advantage of any opportunities that may arise.

Strategic goals

The overarching intent of the Action Plan is captured by a number of high-level strategic goals; the expectation is that if these goals are met, the future vision for Canmore will be achieved. The following strategic goals are suggested for the Action Plan:

- ✓ Mainstream climate adaptation and resilience into existing operations, programs, plans and strategies—i.e., decisions are made on the basis of a risk management framework accounting for projected climate change;
- ✓ Enhance the capacity of Town of Canmore departments and staff to effectively manage the complex threats and opportunities presented by climate change;
- ✓ Increase community awareness of projected climate changes and potential impacts on the economy and local businesses; the natural environment; property, infrastructure and services; and the health and lifestyles of residents; and
- ✓ Manage material risks and opportunities with actions that are effective, affordable, feasible, acceptable to the community, equitable, and flexible.

Climate adaptation and resilience objectives, actions, and resourcing

Canmore is already undertaking numerous actions that will help to mitigate aspects of priority climate risks (e.g., many actions have already been formulated to mitigate flooding risk on mountain creeks), and help to take advantage of potential opportunities from climate change, even though these actions have not traditionally been labelled as “climate adaptation or resilience actions”. As our approach to formulating actions suggests, current actions to manage priority risks and opportunities serve as an important starting point for identifying actions that will be necessary in the future to deal with changing climatic conditions. Existing actions or commitments made by the Town of Canmore that would help manage priority risks and opportunities, compiled at the action planning meetings, are listed in Appendix F.

New or improved actions identified at the meetings are presented in tabular form below. A separate table is provided for each action; tables are organized by priority risks and opportunities. Each table includes four key pieces of information: 1) the identified action; 2) bounded investment and annual costs, implementation timeframe, and implementation lead; 3) an overall evaluation score, which indicates the performance of the action against the set evaluation criteria; and 4) a list of other priority risks and opportunities that the action helps to address.

The tables provide a "shopping list" of potential actions that may be considered for implementation on an annual basis, to match concurrent priorities and resources.

R3: Forest fire

Planning objectives:

1. Reduce the impacts of forest fire on buildings, property and public safety; and
2. Respond to, and recover from forest fires in a timely and efficient manner.

Risk mitigation actions:

ACTION R3.1: Update the FireSmart mitigation strategy to reflect the current state of the forest and high risk areas, and the vulnerability of, and mitigation options for, public buildings and facilities							
Implementation lead:	**Protective Services**						
Investment cost:	**$$**	Annual cost:	**None**	Timeframe:	**Short-term**	Assessment Score:	**23**
Also supports mitigation of risks:	**None**						

ACTION R3.2: Develop a smoke alert / health advisory policy to manage smoke-related air quality issues, including: communicating potential health impacts to residents (via website, etc.); idling policies when air quality is poor; policies / triggers for closures of outdoor facilities, cancellation of outdoor events, and recommended levels of outdoor activity							
Implementation lead:	**Protective Services**						
Investment cost:	**$**	Annual cost:	**None**	Timeframe:	**Short-term**	Assessment Score:	**21**
Also supports mitigation of risks:	**None**						

ACTION R3.3:

Develop a more active relationship with adjacent land owners and managers (Parks Canada, Province of Alberta, MD of Bighorn) to conduct regional fire planning and risk mitigation

Implementation lead: **Protective Services**

Investment cost: **$** Annual cost: **$** Timeframe: **Short-term** Assessment Score: **21**

Also supports mitigation of risks: **None**

ACTION R3.4:

Host an additional emergency preparedness or fire prevention campaign during the year

Implementation lead: **Protective Services**

Investment cost: **$** Annual cost: **$$** Timeframe: **Short-term** Assessment Score: **21**

Also supports mitigation of risks: **Creek flooding, Bow River flooding, heavy snowfall, extreme wind**

ACTION R3.5:

Develop and implement education campaign to raise awareness of forest fire risk in high risk areas of town, and mitigation, preparedness and response options for private property

Implementation lead: **Protective Services**

Investment cost: **$** Annual cost: **$$** Timeframe: **Short-term** Assessment Score: **21**

Also supports mitigation of risks: **None**

ACTION R3.6:

Hire a part-time Municipal Emergency Plan coordinator (or a full-time Coordinator that is shared across the region)

Implementation lead: **Protective Services**

Investment cost: **$** Annual cost: **$$$** Timeframe: **Medium-term** Assessment Score: **21**

Also supports mitigation of risks: **Creek flooding, Bow River flooding, heavy snowfall, extreme wind**

ACTION R3.7:

Strengthen the Engineering Design and Construction Guidelines and Land Use Bylaw to consider including requirements for fire resistant roofing and siding materials in all new development, and expand scope of requirements to cover single-family dwellings

Implementation lead: **Engineering and Planning & Development**

Investment cost: **$** Annual cost: **None** Timeframe: **Medium-term** Assessment Score: **19**

Also supports mitigation of risks: **None**

ACTION R3.8:

Offer incentives (e.g., rebate retrofit program) for improved "FireSmarting" on existing private property in high risk areas, including education on managing the surrounding land

Implementation lead: **Planning & Development and Protective Services**

Investment cost: **$** Annual cost: **$$$** Timeframe: **Medium-term** Assessment Score: **18**

Also supports mitigation of risks: **None**

R4: Bow River flooding

Planning objectives:

1. Reduce the impacts of river flooding on people, infrastructure, property and the natural environment
2. Ensure response to and recovery from river flooding is timely and efficient

Risk mitigation actions:

ACTION R4.1:

Install backflow prevention valves in vulnerable civic facilities and buildings

Implementation lead: **Facilities**

Investment cost: **$$** Annual cost: **None** Timeframe: **Medium-term** Assessment Score: **21**

Also supports mitigation of risks: **Storm water flooding**

ACTION R4.2:

Use flood resilient bridge designs (e.g., modular units, free span bridges) along popular hiking, biking and nordic skiing trails, when bridges are replaced or for new build

Implementation lead: **Engineering and external organizations (e.g. Alberta Parks)**

Investment cost: **$$$** Annual cost: **None** Timeframe: **Ongoing** Assessment Score: **21**

Also supports mitigation of risks: **Creek flooding, storm water flooding**

ACTION R4.3:

Study the need for improved management of stormwater in the valley bottom (including management options), considering the potential for extreme rainfall events to occur during times of high groundwater levels, and winter drainage issues

Implementation lead: **Public Works, EPCOR and Engineering**

Investment cost: **$$** Annual cost: **None** Timeframe: **Short-term** Assessment Score: **20**

Also supports mitigation of risks: **Storm water flooding**

ACTION R4.4:

Purchase submersible pumps for vulnerable civic facilities and buildings

Implementation lead: **Facilities**

Investment cost: **$$$** Annual cost: **None** Timeframe: **Medium-term** Assessment Score: **20**

Also supports mitigation of risks: **Storm water flooding**

ACTION R4.5:

Purchase additional temporary flood protection equipment such as tiger dams, sand bags and HESCO barriers

Implementation lead: **Protective Services**

Investment cost: **$$$** Annual cost: **None** Timeframe: **Medium-term** Assessment Score: **20**

Also supports mitigation of risks: **Storm water flooding**

ACTION R4.6:

Increase public awareness of local hazards by installing signage along popular hiking and biking trails, and raising awareness of hazards via the website

Implementation lead: **Public Works (Parks Department) and external organizations (e.g. Alberta Parks)**

Investment cost: **$$** Annual cost: **$** Timeframe: **Short-term** Assessment Score: **20**

Also supports mitigation of risks: **Creek flooding**

ACTION R4.7:

Install a water gauge on the Bow River within the Canmore townsite to track real-time local river flows and long-term trends

Implementation lead: **Engineering**

Investment cost: **$$** Annual cost: **$** Timeframe: **Medium-term** Assessment Score: **20**

Also supports mitigation of risks: **None**

ACTION R4.8:

Conduct a Bow River Flood Risk Assessment, when new flood hazard maps are available from Government of Alberta

Implementation lead: **Engineering**

Investment cost: **$$$** Annual cost: **None** Timeframe: **Medium-term** Assessment Score: **19**

Also supports mitigation of risks: **None**

R5: Creek flooding

Planning objectives:

1. Reduce the impacts of creek flooding on people, infrastructure, property and the natural environment
2. Ensure response to and recovery from creek flooding is timely and efficient

Risk mitigation action:

ACTION R5.1:

Explore mechanisms and options for funding the long-term operations and maintenance of creek hazard mitigation infrastructure

Implementation lead: **Protective Services and Engineering**

Investment cost: **$** Annual cost: **None** Timeframe: **Medium-term** Assessment Score: **20**

Also supports mitigation of risks: **None**

R1: Stormwater flooding

Planning objective:

1. Manage stormwater to avoid localized flooding and impacts

Risk mitigation actions:

ACTION R1.1:

Develop and launch an educational program for households to minimize adverse effects of stormwater run-off from private properties

Implementation lead: **Communications, Engineering and Planning & Development**

Investment cost: **$$** Annual cost: **$** Timeframe: **Short-term** Assessment Score: **23**

Also supports mitigation of risks: **None**

ACTION R1.2:

Identify and map existing stormwater flood problem areas and sources

Implementation lead: **Engineering**

Investment cost: **$** Annual cost: **None** Timeframe: **Short-term** Assessment Score: **23**

Also supports mitigation of risks: **None**

ACTION R1.3:

Evaluate use and applicability to Canmore of pervious pavement and other innovative technologies / options to reduce stormwater run-off or retain stormwater on-site

Implementation lead: **Engineering**

Investment cost: **$** Annual cost: **None** Timeframe: **Short-term** Assessment Score: **23**

Also supports mitigation of risks: **Bow River flooding**

ACTION R1.4:

Conduct an engineering vulnerability assessment (e.g., like PIEVC) to characterize and prioritize climate change risks posed to the stormwater system

Implementation lead: **Engineering**

Investment cost: **$$** Annual cost: **None** Timeframe: **Medium-term** Assessment Score: **21**

Also supports mitigation of risks: **None**

ACTION R1.5:

Increase budget and resources for ongoing maintenance of the stormwater management system

Implementation lead: **Public Works, EPCOR, Engineering and Finance**

Investment cost: **None** Annual cost: **$$$** Timeframe: **Short-term** Assessment Score: **22**

Also supports mitigation of risks: **None**

ACTION R1.6:

Conduct a study to identify options for improved management of stormwater in the valley bottom, considering the potential for extreme rainfall events to occur during times of high groundwater levels, and winter drainage issues

Implementation lead: **Engineering**

Investment cost: **$$** Annual cost: **None** Timeframe: **Medium-term** Assessment Score: **21**

Also supports mitigation of risks: **Bow River flooding**

ACTION R1.7:

Update IDF curves to reflect current and projected precipitation patterns, incorporating climate change

Implementation lead: **Engineering**

Investment cost: **$$** Annual cost: **None** Timeframe: **Short-term** Assessment Score: **19**

Also supports mitigation of risks: **None**

ACTION R1.8:

Strengthen the Engineering Design and Construction Guidelines and Land Use Bylaw to include new techniques and requirements for on-site storm water retention and management

Implementation lead: **Engineering and Planning & Development**

Investment cost: **$** Annual cost: **None** Timeframe: **Short-term** Assessment Score: **18**

Also supports mitigation of risks: **None**

R7: **Water supply shortage**

Planning objectives:

1. Ensure adequate supply of quality water to meet the needs of residents and businesses
2. Increase water conservation and recycling
3. Efficiently manage water shortage events

Risk mitigation actions:

ACTION R7.1:

Monitor and evaluate water pricing rates and structures for residential and commercial users annually or as required to ensure water conservation is encouraged

Implementation lead: **Public Works and EPCOR**

Investment cost: **None** Annual cost: **$** Timeframe: **Ongoing** Assessment Score: **23**

Also supports mitigation of risks: **None**

ACTION R7.2:

Renew the TransAlta agreement to require adequate water supply from the Rundle Forebay surface water treatment plant

Implementation lead: **Public Works**

Investment cost: **$** Annual cost: **None** Timeframe: **Medium-term** Assessment Score: **23**

Also supports mitigation of risks: **None**

ACTION R7.3:

Develop a Water Shortage Response Plan

Implementation lead: **Public Works and EPCOR**

Investment cost: **$$** Annual cost: **None** Timeframe: **Medium-term** Assessment Score: **23**

Also supports mitigation of risks: **None**

ACTION R7.4:

Provide additional budget and resources to support expanded implementation of the leak detection and repair program

Implementation lead: **Public Works, EPCOR and Finance**

Investment cost: **None** Annual cost: **$$** Timeframe: **Short-term** Assessment Score: **22**

Also supports mitigation of risks: **None**

ACTION R7.5:

Expand communications and education related to the water conservation and efficiency aspects of the Environmental Sustainability Action Plan

Implementation lead: **Planning & Development, Public Works and Communications**

Investment cost: **None** Annual cost: **$$** Timeframe: **Short-term** Assessment Score: **22**

Also supports mitigation of risks: **None**

ACTION R7.6:

Re-introduce a grant/rebate program for property-level water conservation and efficiency upgrades and expand scope of measures offered

Implementation lead: **Public Works and Planning & Development**

Investment cost: **$** Annual cost: **$$$** Timeframe: **Medium-term** Assessment Score: **20**

Also supports mitigation of risks: **None**

ACTION R7.7:

Review and update the Utilities Master Plan to include the potential impacts of climate change on local water supply and demand, and the consideration of compound risks, such as low flow / water levels and pump failures at reservoir

Implementation lead: **Public Works and EPCOR**

Investment cost: **$$** Annual cost: **None** Timeframe: **Medium-term** Assessment Score: **20**

Also supports mitigation of risks: **None**

R13: Heavy snowfall event, blizzard

Planning objectives:

1. Reduce the impacts of heavy snowfall events and blizzards on buildings, property and public safety
2. Response to and recovery from heavy snowfall events and blizzards is timely and efficient

Risk mitigation actions:

ACTION R13.1:

Increase the public's awareness of their responsibilities for snow and ice removal within the Traffic and Road Use Bylaw

Implementation lead: **Bylaw Services, Public Works (Streets & Roads) and Communications**

Investment cost: **$** Annual cost: **$** Timeframe: **Short-term** Assessment Score: **23**

Also supports mitigation of risks: **Freeze-thaw cycles**

ACTION R13.2:

Modify existing rules for prioritizing sidewalks for snow and ice clearance to include public safety parameters linked with heavy snowfall events (including accounting for the vulnerability of specific user groups, like the elderly)

Implementation lead: **Public works (Streets & Roads)**

Investment cost: **$** Annual cost: **None** Timeframe: **Short-term** Assessment Score: **23**

Also supports mitigation of risks: **Freeze-thaw cycles**

ACTION R13.3:

Conduct a simple snow load risk assessment of municipal facilities to determine high risk facilities and help prioritize snow clearing and maintenance operations

Implementation lead: **Facilities**

Investment cost: **$** Annual cost: **None** Timeframe: **Short-term** Assessment Score: **22**

Also supports mitigation of risks: **None**

ACTION R13.4:

Increase the availability of tools and equipment for site-specific snow clearing at municipal facilities through the purchase of additional equipment and / or more efficient use / sharing of existing of equipment

Implementation lead: **Facilities**

Investment cost: **$** Annual cost: **None** Timeframe: **Short-term** Assessment Score: **22**

Also supports mitigation of risks: **None**

ACTION R13.5:

Adjust operational snow and ice clearing procedures to better manage heavy snow loads and freeze-thaw cycles, including clearing and off-site storage of snow to reduce risk of ice build-up on sidewalks and trails

Implementation lead: **Public Works (Streets & Roads)**

Investment cost: **None** Annual cost: **$$** Timeframe: **Short-term** Assessment Score: **20**

Also supports mitigation of risks: **Freeze-thaw cycles**

ACTION R13.6:

Install power surge protection and back-up power sources at priority municipal facilities (beyond critical facilities)

Implementation lead: **Facilities**

Investment cost: **$$$** Annual cost: **None** Timeframe: **Long-term** Assessment Score: **20**

Also supports mitigation of risks: **Extreme wind storms**

ACTION R13.7:

Conduct a hazard assessment (including snow load and wind risk) as part of the urban forest management plan to identify and subsequently remove hazardous trees across the community

Implementation lead: **Public Works (Parks Department)**

Investment cost: **$$** Annual cost: **$$** Timeframe: **Ongoing** Assessment Score: **18**

Also supports mitigation of risks: **Extreme wind storm**

ACTION R13.8:

Develop an internal policy to exceed the snow load design requirements in the Alberta Building Code for new municipal developments and large renovation projects

Implementation lead: **Facilities**

Investment cost: **$** Annual cost: **None** Timeframe: **Medium-term** Assessment Score: **15**

Also supports mitigation of risks: **None**

ACTION R13.9:

Bury power lines underground in areas where overhead lines are vulnerable to extreme wind and snow loading

Implementation lead: **Engineering and Planning & Development in conjunction with Electricity suppliers**

Investment cost: **$$$$** Annual cost: **None** Timeframe: **Long-term** Assessment Score: **15**

Also supports mitigation of risks: **Extreme wind storm**

R6: Extreme wind storm

Planning objectives:

1. Reduce the impacts of extreme wind events on buildings, property and public safety
2. Response to and recovery from extreme wind events is timely and efficient

Risk mitigation action:

ACTION R6.1:

Strengthen the event permitting process requiring applicants to specifically address the risk of extreme wind storms in Emergency Response Plans

Implementation lead: **Special Events Coordinator**

Investment cost: **$** Annual cost: **None** Timeframe: **Short-term** Assessment Score: **22**

Also supports mitigation of risks: **None**

R14: Freeze-thaw cycle

Planning objective:

1. Minimize the impacts of freeze-thaw cycles on infrastructure, transportation access and public safety

Risk mitigation actions:

ACTION R14.1:

Improve coordination between the Engineering, Public Works, Planning & Development and Protective Services regarding planning and design of new roads and sidewalks, and upgrades to existing roads and sidewalks

Implementation lead: **Engineering, Public Works, Planning & Development and Protective Services (Fire & Rescue)**

Investment cost: **None** Annual cost: **$** Timeframe: **Short-term** Assessment Score: **22**

Also supports mitigation of risks: **Stormwater flooding, heavy snowfall, blizzard**

ACTION R14.2:

Improve processes to ensure utility road cuts are properly rehabilitated and consider permit fees to offset road rehabilitation costs

Implementation lead: **Engineering**

Investment cost: **None** Annual cost: **$** Timeframe: **Short-term** Assessment Score: **22**

Also supports mitigation of risks: **None**

ACTION R14.3:

Enhance the pavement management strategy by focusing on preventative maintenance, researching and utilizing better asphalt mixes and road structures, including collaboration with City of Calgary, and including links to the internal log of crack sealing and pot hole work

Implementation lead: **Engineering and Public Works**

Investment cost: **$** Annual cost: **$** Timeframe: **Short-term** Assessment Score: **21**

Also supports mitigation of risks: **None**

ACTION R14.4:

Strengthen the Engineering Design and Construction Guidelines to identify and map frost susceptible soils and better address freeze-thaw impacts such as requiring the use of native (granular) materials

Implementation lead: **Engineering**

Investment cost: **$$-$$$** Annual cost: **None** Timeframe: **Medium-term** Assessment Score: **18**

Also supports mitigation of risks: **None**

O1: Increase in summer recreation opportunities

Planning objective:

1. Maximize benefits of potential climate-related tourism and recreation opportunities

Actions to support realization of priority opportunities:

ACTION O1.1:

Increase promotion of Canmore as a bike friendly community / leading bike destination

Implementation lead:	**Communications and Engineering and external organizations (e.g., Alberta Environment & Parks, Canmore's destination marketing / economic development organization)**						
Investment cost:	**None**	Annual cost:	**$$**	Timeframe:	**Short-term**	Assessment Score:	**22**
Also supports:	**None**						

ACTION O1.2:

Promote and support additional community and cultural events (e.g., music, food, etc.) in extended shoulder seasons and to coincide with additional sporting events at Nordic Center

Implementation lead:	**Special Events Coordinator in conjunction with external organizations (e.g. Alberta Environment & Parks and Canmore's destination marketing / economic development organization)**						
Investment cost:	**None**	Annual cost:	**$$**	Timeframe:	**Short-term**	Assessment Score:	**22**
Also supports:	**Winter tourism competitive advantage**						

ACTION O1.3:

Promote and provide additional support to expand local Roam bus service (e.g., subsidized fares for defined introductory period and during special events)

Implementation lead:	**Engineering**						
Investment cost:	**$**	Annual cost:	**$$**	Timeframe:	**Short-term**	Assessment Score:	**21**
Also supports:	**Winter tourism competitive advantage**						

ACTION O1.4:

Expand and enhance facilities and infrastructure that support summer and shoulder season activities such as running, hiking, biking and fat biking (which is less vulnerable to climate variability), including development of a destination hiking trail, promotion of in-town trails, and expansion of fat biking trails in winter

Implementation lead:	**Planning & Development, Public Works (Parks Department) and Engineering in conjunction with external organizations (e.g. Alberta Environment & Parks and Canmore's destination marketing / economic development organization)**						
Investment cost:	**$$$**	Annual cost:	**$$**	Timeframe:	**Medium-term**	Assessment Score:	**18**
Also supports:	**None**						

O4: Extended construction season

The potential opportunity for an extended construction season, and the associated benefits of fewer transportation disruptions, increased growth and development, and cost savings for the Town, was identified as a priority opportunity; however, specific objectives or actions have not been identified to date.

O5: Increase in winter tourism competitive advantage

Planning objective:

1. Maximize benefits of potential climate-related tourism and recreation opportunities

Action to support realization of priority opportunities:

ACTION O5.1: Monitor and adapt snow making and storage program as climate changes to continue to provide early season (Oct-Nov) training facilities for nordic athletes from across the globe							
Implementation lead:	**Alberta Environment & Parks**						
Investment cost:	**None**	Annual cost:	**$**	Timeframe:	**Ongoing**	Assessment Score:	**22**
Also supports:	**None**						

7. IMPLEMENTATION & NEXT STEPS

ACT

The recommended actions listed in Section 6 serve as a 'shopping-list'. Town staff and other community stakeholders should establish priorities from the listed actions, and begin implementation as soon as practical. Consideration should be given to forming a cross-departmental and cross-community implementation team from among workshop participants to oversee implementation of the Action Plan. A number of actions can be implemented quickly with minimal investment, whereas other actions have longer-term timeframes, require a higher level of investment, and may require a more detailed implementation strategy with specific budgets and funding sources, timelines and milestones for specific activities, and defined roles and responsibilities for specific stakeholders and groups.

Effective communication with the public and other community stakeholders about climate change impacts can be valuable in helping them understand why certain measures are needed. Additional community outreach and in partnership with key community stakeholders, can be an effective way to both:

- ✓ Gather input from community members on the content of the Action Plan; and
- ✓ Promote the Town's efforts to make the community more resilient.

MAINSTREAMING

This Action Plan is developed as a 'stand-alone' document. However, it is important that climate resilience is integrated (i.e., 'mainstreamed')—as a matter of routine—into Town strategies, plans, policies, programs, projects, and administrative processes. For example:

- ✓ Climate resilience should be considered in all future land use and development decisions, including administrative processes such as bids, tenders and contracts for planning and development work;
- ✓ Strategic plans (e.g., the Municipal Development Plan and the Open Space and Trails Plan) and neighborhood scale plans should consider potential future climate change impacts; and
- ✓ Decisions related to the design, maintenance, and upgrading of long-life infrastructural assets and facilities should likewise consider future climate changes and impacts.

REVIEW AND UPDATE

Building resilience to climate change is not a static process. The priority risks and opportunities identified in this Action Plan, along with the recommended actions to address them, should be viewed as a preliminary step in Canmore's journey towards a climate resilient future. The climate resilience action planning process is dynamic. For a start, the rapidly changing scientific knowledge about the physical impacts of climate change means that climate change risk and opportunity assessments are not one-off activities, but rather need to be reviewed and updated regularly. This Action Plan should be reviewed and updated every 5 years to ensure it remains relevant and effective, taking account of:

- ✓ Lessons learned from the implementation of actions;
- ✓ New scientific information about climate projections and corresponding impacts; and
- ✓ Changes to the Town's goals and policies.

Keeping the Action Plan relevant may only involve a few minor adjustments, or it may require revisiting some of the steps in the climate resilience planning process and preparing a new Action Plan.

8. APPENDIX A: WORKSHOP PARTICIPANTS

The following staff members and local stakeholders supported development of this report.

Name	Title
Andreas Comeau	Manager of Public Works, Town of Canmore
Greg Burt	Manager of Protective Services, Town of Canmore
Alaric Fish	Manager of Planning and Development, Town of Canmore
Brian Kinzie	Development Project Engineer, Town of Canmore
Felix Camire	Project Engineer, Town of Canmore
Stephen Hanus	Manager of Facilities, Town of Canmore
Joseph Rau	Asset Management Coordinator, Town of Canmore
Matthew McCrank	Epcor Manager, Canmore
Vi Sandford	Councillor, Town of Canmore
Serge Metikosh	Environmental Advisory Review Committee member
Natalie Cooper	Environmental Advisory Review Committee member
David Reynolds	Environmental Advisory Review Committee member
Laura Lynes	The Rockies Institute
Mark Storie	Kananaskis Regional Director, Alberta Environment and Parks
Lori Rissling Wynn	Development Planner/Sustainability Coordinator, Town of Canmore
Michael Roycroft	Area Manager, Specialized Facilities and Trails, Canmore Nordic Centre Provincial Park, Alberta Environment and Parks
Ron Remple	Executive Director Bow Valley Builders and Developers Association; and Canmore Business and Tourism

9. APPENDIX B: SUMMARY OF RISKS AND OPPORTUNITIES

ID	Source	Impact event	Consequences	Consequence level	Likelihood level	Risk level	Action planning
R1	Increase in the number of extreme precipitation events	Recurring risk of **stormwater system being overwhelmed**, leading to localized flooding	○ Inconvenience for residents from transport disruption ○ Disruption to economic activities with loss of output ○ Transport delays affecting shipping of supplies and products ○ Decrease water quality ○ Increased bank erosion and changes to channel morphology and habitat ○ Damage to property and infrastructure ○ Interruption to lifelines (water, sewer) ○ Increased costs to town	MODERATE	MODERATE-HIGH	MEDIUM PRIORITY	**MANAGE**
R2	Less precipitation falling as snow, warmer winter temperatures, and increased temperature variability	Recurring risk of **avalanche** affecting Spray Lakes access	○ Inconvenience for residents from road closure ○ Disruption to economic activities with loss of output ○ Damage to wildlife habitat and forest ○ Damage to town reputation with external stakeholders (due to perceived safety risks)	LOW	HIGH	LOW PRIORITY	**MONITOR & REVIEW**
R3	Warmer summer temperatures, more periods of extreme heat, less summer precipitation, and increase in intensity of summer storms (lightning strikes)	Recurring risk of **forest fire**	○ Public safety concerns ○ Smoke inhalation, poor air quality related illnesses ○ Impairment of visual amenity ○ Decline in economic activities with loss of output, due to reduced tourist visitation ○ Impact to, loss of, trees and other wildlife habitat and ecosystems ○ Damage to property and infrastructure ○ Interruption to lifelines (power and communications) ○ Increased costs to town and demands on emergency services	HIGH	MODERATE	HIGH PRIORITY	**MANAGE**
R4	Increase in the number of extreme precipitation events, earlier peak stream flow, and more spring precipitation as rain	Recurring risk of **Bow River flooding**	○ Public health and safety concerns, including longer-term mental health (stress and anxiety) ○ Disruption in, loss of, economic activities with loss of output ○ Bank erosion and damage to (wildlife) habitat and ecosystems ○ Damage to, loss of, property and infrastructure ○ Interruption to lifelines (power, water and sewer) ○ Evacuations, damage to towns reputation ○ Increased costs to town and demands on emergency services	HIGH	MODERATE	HIGH PRIORITY	**MANAGE**

ID	Source	Impact event	Consequences	Consequence level	Likelihood level	Risk level	Action planning
R5	Increase in the number of extreme precipitation events, earlier peak stream flow, and more spring precipitation as rain	Recurring risk of **creeks flooding**	○ Public health and safety concerns, including longer-term mental health (stress and anxiety) ○ Disruption in, loss of, economic activities with loss of output ○ Bank erosion and damage to (wildlife) habitat and ecosystems ○ Damage to, loss of, property and infrastructure ○ Interruption to lifelines (power, water and sewer) ○ Evacuations, damage to towns reputation ○ Increased costs to town and demands on emergency services	MODERATE-HIGH	MODERATE	MEDIUM PRIORITY	**MANAGE**
R6	Increase in intensity of summer storms	Recurring risk of **extreme winds**	○ Public safety concerns ○ Disruption to economic activities with loss of output, from fallen trees and transport disruption, and loss of lifelines ○ Damage to, loss of, trees ○ Damage to property and infrastructure ○ Interruption to lifelines (power and communications) ○ Increased costs to town and demands on emergency services	MODERATE	MODERATE	MEDIUM PRIORITY	**MANAGE**
R7	Warmer summer temperatures, less summer precipitation, and reduced extent of glacier feeding rivers	Recurring risk of **water supply shortages**	○ Inconvenience to residents from water use restrictions ○ Deterioration in water-based recreation ○ Decline to economic activities and output for selected businesses ○ Deterioration in water quality with implications for aquatic ecosystems ○ Interruption to lifelines (water supply) ○ Increased costs to town from changes to water treatment to maintain standards	MODERATE	MODERATE	MEDIUM PRIORITY	**MANAGE**
R8	Increase in number of extreme precipitation event	Recurring risk of **sediment loading-turbidity**	○ Deterioration in water quality with implications for aquatic ecosystems ○ Increased costs to town from changes to water treatment to maintain standards	LOW-MODERATE	MODERATE	LOW PRIORITY	**MONITOR & REVIEW**

ID	Source	Impact event	Consequences	Consequence level	Likelihood level	Risk level	Action planning
R9	Increase in number of extreme heat events and record temperatures	Recurring risk of **heat stress on vulnerable populations**	○ Public health concerns (sleep disturbance, heat stress and associated morbidity, including stress and anxiety) ○ Reduced productivity of workers ○ Increased demands on emergency services	LOW-MODERATE	MODERATE	LOW PRIORITY	**MONITOR & REVIEW**
R10	Warmer temperatures, and increase in number of extreme heat events and record temperatures	Trending risk toward **increased water demand** by households, businesses, and other consumers	○ Increased competition between users, including in-situ uses in water sources ○ Increased costs to town from changes to water services (abstraction, treatment, provision, sewer)	LOW-MODERATE	MODERATE	LOW PRIORITY	**MONITOR & REVIEW**
R11	Less precipitation falling as snow, warmer winter temperatures, and reduced winter snowpack	Trending risk toward **decline in traditional winter recreation activities** for residents and tourists	○ Deterioration in quality of life for residents, and deterioration in visitor experience for tourists ○ Loss of exercise opportunities for residents, with health issues, including increased stress and anxiety ○ Decline in economic activity and output for selected businesses, with potential job losses ○ Potential for reduction in property values as a result of "out-migration" ○ Damage to Canmore's reputation re winter recreation opportunities - perception of Canmore	LOW-MODERATE	MODERATE	LOW PRIORITY	**MONITOR & REVIEW**
R12	Earlier spring peak flow, decreased flow in summer, and warmer waters	Trending risk toward **adverse impacts on fish and aquatic ecosystems**	○ Change in native fish species	LOW-MODERATE	MODERATE	LOW PRIORITY	**MONITOR & REVIEW**
R13	Increased in extreme precipitation events in winter	Recurring risk of **heavy snowfall events, blizzards**	○ Public safety concerns ○ Inconvenience – snow clearing and getting about ○ Disruption to economic activity, mainly from transport disruption and people staying at home ○ Stress to wildlife ○ Interruption of lifelines (power) ○ Property damage from excess snow loading ○ Costs to town from snow clearing, sanding, and clean up ○ Increased demands on emergency services, also with costs implications for town	MODERATE	MODERATE	MEDIUM PRIORITY	**MANAGE**

ID	Source	Impact event	Consequences	Consequence level	Likelihood level	Risk level	Action planning
R14	Increased variability of temperatures in winter, early spring and late autumn	Recurring risk of increased frequency of **freeze-thaw cycles**	○ Public safety concerns relating to the potential for injuries ○ Reduction in recreation opportunities, like skating ○ Disruption to economic activity, mainly from transport disruption ○ Costs to town from increased road maintenance, sanding, and clean up, as well as repairs to, and replacement of, underground infrastructure	LOW-MODERATE	MODERATE-HIGH	MEDIUM PRIORITY	**MANAGE**
R15	Shifting ecosystems upland, and reduced alpine tundra	Recurring risk of **increased human contact with wildlife**	○ Public safety concerns, including potential for injuries and fatalities ○ Viewing opportunities (on the plus side) ○ Need to remove wildlife from town (stress to wildlife), and sometimes need to destroy it ○ Costs to town from removal or destruction of wildlife ○ Adverse impact on Town's image and reputation, from safety concerns and need to destroy wildlife	LOW-MODERATE	MODERATE	LOW PRIORITY	**MONITOR & REVIEW**
R16	Less periods of extreme cold spells, warmer temperatures	Trending risk towards **increased incidence of vector-borne diseases**	○ Public health concerns, primarily related to morbidity (illnesses and disease) ○ Loss of economic activity and output, if tourists opt to stay away to reduce exposure to insects (ticks, mosquitos) carrying vectors ○ Stress to, or loss of, pets and wildlife ○ Adverse impact on Town's image	LOW-MODERATE	MODERATE	LOW PRIORITY	**MONITOR & REVIEW**
R17	Less periods of extreme cold spells, warmer temperatures	Trending risk towards **increase prevalence of invasive species**	○ Loss of visual amenity (e.g., from pine beetle tree loss) ○ Loss of economic activity and output, if tourist visitation or experience impacted ○ Native species displacement ○ Forest loss, loss of habitat	LOW-MODERATE	MODERATE	LOW PRIORITY	**MONITOR & REVIEW**

ID	Source	Impact event	Consequences	Consequence level	Likelihood level	Opportunity level	Action planning
O1	Less precipitation falling as snow, warmer spring and fall temperatures, and reduced winter snowpack	Trending opportunity towards **increase in summer season recreation activities** for residents and tourists	○ Increased amenity for residents who favour summer recreation activities ○ Increase in economic activity and output for selected businesses, with job benefits	MODERATE	MODERATE-HIGH	MEDIUM PRIORITY	**MANAGE**
O2	Warmer temperatures in spring and summer, increased growing season	Trending opportunity towards **increase in food growing prospects**	○ Increased amenity for residents, who derive satisfaction from home gardening ○ Increase in economic activity and output, from gardening suppliers ○ Potential for new agricultural businesses	LOW-MODERATE	MODERATE	LOW PRIORITY	**MONITOR & REVIEW**
O3	Warmer temperatures	Trending opportunity towards **reduced heating demand**	○ Energy bill savings to residents, businesses and town ○ Reduction in fossil fuel combustion with associated reductions in emissions of GHG and other air pollutants	LOW-MODERATE	MODERATE	LOW PRIORITY	**MONITOR & REVIEW**
O4	Warmer temperatures in shoulder seasons	Trending opportunity towards **extended construction season**	○ Less transport disruptions, with less disruption to economic and recreation activities ○ Increase in development, growth (projects completed sooner) ○ Cost savings to town, and lower procurement prices	MODERATE	MODERATE	MEDIUM PRIORITY	**MANAGE**
O5	Relative climate change in winter vis-à-vis rest of world – preferable conditions in Canmore	Trending opportunity towards **increased capture of winter sporting events** scheduled in other countries	○ Increase in amenity for residents, from spectating and participating in related side events ○ Increase in tourist visitation associated with sporting events ○ Increase in economic activity and output, with job benefits ○ Enhanced town image and publicity	MODERATE	MODERATE	MEDIUM PRIORITY	**MANAGE**

10. APPENDIX C: SCALE FOR RATING THE CONSEQUENCES OF RISKS

Rating	Description			
	Health & lifestyle	Economy	Environment	Property, infrastructure & services
(1) **Low**	• No fatalities or serious injuries or illness • Minor temporary adverse impacts on lifestyles	• Negligible impact to local economy, few businesses affected • Insignificant economic costs	• Minor adverse impacts on wildlife, habitat, ecosystems and environmental amenities	• Minor damage to property & infrastructure (incl. critical facilities and lifelines • Minimal, localized interruption of service • No evacuations • Minimal cost to municipality
(2)				
(3) **Moderate**	• Potential for some serious injuries and minor injuries • Moderate yet temporary impacts on lifestyles	• Sector specific, short-term disruption / impact to local economy • Moderate economic • Local media coverage	• Isolated, localized and/or short-term damage to wildlife, habitat, ecosystems and environmental amenities	• Localized damage to property & infrastructure (incl. critical facilities and lifelines) • Short-term interruption of services • Localized evacuations • Moderate cost to municipality
(4)				
(5) **High**	• Potential for multiple fatalities and/or serious injuries and illness • Major, long-term impacts on lifestyles	• Widespread / longer-term disruption to key economic sectors • Major economic costs • National media coverage	• Widespread and irreversible damage to wildlife, habitat, ecosystems and environmental amenities (e.g. trails)	• Major, widespread damage to property & infrastructure (incl. critical facilities and lifelines) • Extensive long-term interruption of services • Widespread evacuations • Major cost to municipality

11. APPENDIX D: SCALE FOR RATING THE CONSEQUENCES OF OPPORTUNITIES

Rating	Description
(1) **Low**	• Minor increase in economic output for a few select businesses, minor boost in jobs for a few select businesses • Minor improvement in recreation, amenity or lifestyle benefits for select groups of residents • Minor cost savings to municipality, businesses or residents
(2)	
(3) **Moderate**	• Moderate increase in economic output, moderate boost in jobs, economic benefits to a sector • Moderate improvement in recreation, amenity or lifestyle benefits for select groups of residents • Moderate cost savings to municipality, businesses or residents
(4)	
(5) **High**	• Major increase in economic output for town, major boost in jobs for town • Major improvement in recreation, amenity or lifestyle benefits for majority of residents • Major cost savings to municipality, businesses or residents

12. APPENDIX E: SCALE FOR THE RATING THE LIKELIHOOD OF CONSEQUENCES

Rating	Recurring Impact	Trending Impact
(1) **Low**	Once in 50 years or more	*Very unlikely* – less than 5% chance of occurrence in next 50 years
(2)	Once in 10 to 50 years	*Unlikely* – 5% to 35% chance of occurrence in next 50 years
(3) **Moderate**	Once in 5 to 10 years	*Possible* – 35% to 65% chance of occurrence in next 50 years
(4)	Once in 1 to 5 years	*Likely* – 65% to 90% chance of occurrence in next 50 years
(5) **High**	Up to once per year	*Almost certain* – 95% or greater chance of occurrence in next 50 years

13. APPENDIX F: SUMMARY OF CURRENT ACTIONS

Wildfire

- Internal policy of installing metal roofs on new facilities
- FireSmart mitigation strategy includes: an updated FireSmart hazard and risk assessment; review of FireSmart mitigation progress; and priority FireSmart mitigation recommendations
- Canmore Fire-Rescue Strategic Plan
- The forest fire emergency response plan identifies channels for getting warnings out to the public, and evacuation procedures
- The Engineering Design and Construction Guidelines include FireSmart recommendations for multi-family developments
- Active forest fuel management occurs throughout high risk areas of the community
- Emergency preparedness campaigns, such as emergency preparedness week
- Some neighbourhoods and houses have roof-top sprinkler systems, and the Canmore Nordic Centre has snow-making equipment which could be utilized during a fire
- Promotion of the Alberta Emergency Alert a mobile phone application

Bow River flooding

- The Land Use Bylaw includes high groundwater area regulations related to habitable floor space and parking within the 1:100 year groundwater table elevation
- The Land Use Bylaw includes flood risk area regulations which delineate the floodway and flood fringe of the Bow River and define permitted and discretionary uses within each
- The Land Use Bylaw contains regulations related to setbacks from bodies of water (riparian areas)
- The Town is working with the Province of Alberta to update flood mapping the Bow River floodplain. Following updated Bow River floodplain, the Land Use Bylaw will be updated to reflect any changes to the floodplain boundaries
- The Town works with Alberta Environment and Parks to determine diking needs and protection
- The Town is developing a Bow River Emergency Plan, modelling and mapping potential flood

water levels, evacuation and response requirements, and public communication policies

- An emergency warning alert system for flood hazards
- Promotion of the Alberta Emergency Alert a mobile phone application
- Temporary flood protection equipment including sand bags and HESCO barriers
- A local weather forecasting system has been established to help predict precipitation

Creek Flooding

- The Mountain Creek Hazard Mitigation Program includes short-term mitigation installed in most mountain creeks in May 2014, as well as longer-term mitigation being planned and installed to protect against an event of similar size to 2013. This involves hazard assessment and mapping, risk assessments and option analysis on Cougar Creek, Three Sisters Creek, Stone Creek, Stoneworks Creek, Pigeon Creek and other creeks.
- Emergency response plans have been developed for individual creeks including triggers for evacuation and key evacuation routes
- The Municipal Development Plan is being updated in 2016 to include new policies related to steep creeks and development, including: safety risk tolerance criteria for new and existing developments; economic risk tolerance requirements; and delineation of steep creek hazard areas including hazard zones, study areas and hold zones, each with specific policies related to development and the development process, including requirements for hazard and risk assessment, and steep creek hazard mitigation in new developments
- The Steep Creek Hazard Policy explains how risk is measured and what criteria is used, the Town's approach to managing steep creek risks and definition of zones for different levels of intensity impacted by steep creeks.

Freeze-thaw cycles

- Operational road and sidewalk maintenance includes salting and sanding, and snow clearing and storage
- The Engineering Design and Construction Guidelines include profiles and designs for roads and sidewalks
- Internal log of crack sealing and pot hole work
- Development of a pavement management strategy including best practices for re-surfacing
- The Traffic and Road Use Bylaw (section 17) controls the removal of snow and ice from sidewalks within the Town, and includes specific responsibilities for residents and businesses

to clear snow and ice from their property.

Extreme wind storm

- Facility-level emergency response plans
- The Alberta Building Code includes regulations for protection of homes against wind
- The Town receives an electrical utility franchise fee which it has used to bury power lines in the downtown core
- The Urban Forest Management Plan includes an inventory of hazard trees and an action plan for removal of trees in specific neighbourhoods
- Back-up power sources exist in critical municipal facilities including the Civic Centre, Fire Hall and public works building
- A portable generator can provide power to critical facilities during a power outage
- The Community Special Event Application Form requires applicants to have an emergency response and evacuation plan, which includes identification and management of risks. All tents and structures larger than 20x20 must be weighted down and inspected by a building inspector

Stormwater system overwhelmed, localized flooding

- The Engineering Design and Construction Guidelines include requirements for stormwater management including Intensity-Duration-Frequency (IDF) curves specifying stormwater design requirements, and low impact development standards
- New developments require a Stormwater Management Plan to specify how stormwater will be managed and retained on site
- Ongoing stormwater maintenance includes regular clearing and cleaning of storm drains
- The Green building checklist and sustainability screening process include options for on-site water retention
- The Land use bylaw includes regulations for high groundwater and flood risk areas, including minimum floor elevations
- Groundwater monitors are in place to monitor water levels

Water supply shortage

- The Environmental Sustainability Action Plan includes goals and targets for water system distribution loss, as well as residential, industrial, commercial and institutional water consumption reduction
- Community-wide water metering of all households
- A residential block rate water pricing structure whereby the top 10 percent of users pay 20 percent more for water
- Off-site levies on development support payment of the long-term operations and maintenance of the water supply system
- The green building checklist for new development includes options for water conservation and efficiency such as low flow fixtures
- The sustainability screening process for new developments includes options for water conservation and efficiency such as on-site water capture and storage
- The Engineering Design and Construction Guidelines include low impact development standards such as on-site water capture and storage, as well as xeriscaping options and requirements
- A wellhead protection zone within the Land Use Bylaw provides protection to the Town's drinking water source, prohibiting uses that could cause groundwater contamination
- Ongoing water supply leak detection and repair program
- The Town has increased landscape efficiency and significantly reduced irrigation across the Town
- The Utilities Master Plan identifies future water supply needs and potential infrastructure upgrades
- The Town once offered a program which provided incentives for low-flow fixtures and residential rain collection barrels. These programs have since been discontinued

Heavy snowfall event, blizzard

- Facility-level emergency response plans
- The Alberta Building Code includes regulations for the slope and pitch of roofs to avoid structural collapse due to snow loading. Building Code regulations are triggered for new developments or when large renovations occur. The Alberta Building Code is updated regularly and some municipal buildings within the Town do not conform to the current standards for roof

pitch and slope

- The facility maintenance program includes policies for roof snow clearing
- The Land Use Bylaw includes architectural and urban design guidelines, some of which relate to roof forms for protection from the elements and aesthetic harmony within the surrounding environment
- The Town receives an electrical utility franchise fee which it has used to bury power lines in the downtown core
- A snow angel program supports seniors in shovelling their driveways
- Back-up power sources exist in critical municipal facilities including the Civic Centre, Fire Hall and public works building
- A portable generator can provide power to critical facilities during a power outage

Increase in summer recreation opportunities

- Biking and hiking trails within and outside town
- A variety community and cultural events (food, musing, sporting, etc.) occur throughout the year
- Designated spots for base jumping and wing suite flying
- The Canmore Community Housing Corporation provides perpetually affordable housing for people who live and work in Canmore
- Transportation, housing and development is managed to support long-term growth management
- Canmore Business and Tourism previously marketed and promoted Canmore as a tourism and recreation destination through brochures, website, tradeshows, and social media

Increase in winter tourism competitive advantage

- The Canmore Nordic Centre (CNC) conducts summer snow making and storage to prolong nordic ski season
- Ongoing facility investments have occurred at CNC and throughout Kananaskis, for example newly developed biathlon and cross-country ski facilities, parking areas, etc.
- Canmore Business and Tourism previously marketed and promoted Canmore as a tourism and recreation destination through brochures, website, tradeshows, and social media

- In 2017, the Bow Valley Regional Transit Services Commission will provide local Roam bus service in Canmore
- A variety community and cultural events (food, musing, sporting, etc.) occur throughout the year

14. APPENDIX G: ACTION EVALUATION SUMMARY

ACTION	Effectiveness	Affordability	Feasibility	Acceptability	Equitability	Flexibility	TOTAL
R3: Forest fire							
R3.1: Update the FireSmart mitigation strategy to reflect the current state of the forest and high risk areas, and the vulnerability of, and mitigation options for, public buildings and facilities	4	3	4	4	4	4	**23**
R3.2: Develop a smoke alert / health advisory policy to manage smoke-related air quality issues, including: communicating potential health impacts to residents (via website, etc.); idling policies when air quality is poor; policies / triggers for closures of outdoor facilities, cancellation of outdoor events, and recommended levels of outdoor activity	3	3	4	4	4	3	**21**
R3.3: Develop a more active relationship with adjacent land owners and managers (Parks Canada, Province of Alberta, MD of Bighorn) to conduct regional fire planning and risk mitigation	4	2	3	4	4	4	**21**
R3.4: Host an additional emergency preparedness or fire prevention campaign during the year	3	2	4	4	4	4	**21**
R3.5: Develop and implement education campaign to raise awareness of forest fire risk in high risk areas of town, and mitigation, preparedness and response options for private property	3	2	4	4	4	4	**21**
R3.6: Hire a part-time Municipal Emergency Plan coordinator (or a full-time Coordinator that is shared across the region)	3	2	4	4	4	4	**21**
R3.7: Strengthen the Engineering Design and Construction Guidelines and Land Use Bylaw to consider including requirements for fire resistant roofing and siding materials in all new development, and expand scope of requirements to cover single-family dwellings	3	4	4	2	3	3	**19**
R3.8: Offer incentives (e.g. rebate retrofit program) for improved “FireSmarting” on existing private property in high risk areas, including education on managing the surrounding land	3	3	3	2	3	4	**18**
R4: Bow River flooding							
R4.1: Install backflow prevention valves in vulnerable civic facilities and buildings	4	2	4	4	4	3	**21**
R4.2: Use flood resilient bridge designs (e.g., modular units, free span bridges) along popular hiking, biking and nordic skiing trails, when bridges are replaced or for new build	3	3	4	4	4	3	**21**
R4.3: Study the need for improved management of stormwater in the valley bottom (including management options), considering the potential for extreme rainfall events to occur during times of high groundwater levels, and winter drainage issues	3	2	3	4	4	4	**20**
R4.4: Purchase submersible pumps for vulnerable civic facilities and buildings	3	2	4	4	4	3	**20**
R4.5: Purchase additional temporary flood protection equipment such as tiger dams, sand bags and HESCO barriers	4	1	4	4	4	3	**20**
R4.6: Increase public awareness of local hazards by installing signage along popular hiking and biking trails, and raising awareness of hazards via the website	3	3	4	3	4	3	**20**

ACTION	Effectiveness	Affordability	Feasibility	Acceptability	Equitability	Flexibility	TOTAL
R4.7: Install a water gauge on the Bow River within the Canmore townsite to track real-time local river flows and long-term trends	4	2	3	4	4	3	**20**
R4.8: Conduct a Bow River Flood Risk Assessment, when new flood hazard maps are available from Government of Alberta	4	1	2	4	4	4	**19**
R5: Creek flooding							
R5.1: Explore mechanisms and options for funding the long-term operations and maintenance of creek hazard mitigation infrastructure	2	3	4	3	4	4	**20**
R1: Storm water system overwhelmed, localized flooding							
R1.1: Develop and launch an educational program for households to minimize adverse effects of stormwater run-off from private properties	4	3	4	4	4	4	**23**
R1.2: Identify and map existing stormwater flood problem areas and sources	4	3	4	4	4	4	**23**
R1.3: Evaluate use and applicability to Canmore of pervious pavement and other innovative technologies / options to slow and retain stormwater on-site	4	3	4	4	4	4	**23**
R1.4: Conduct an engineering vulnerability assessment (e.g., like PIEVC) to characterize and prioritize climate change risks posed to the stormwater system	4	3	3	4	4	4	**22**
R1.5: Increase budget and resources for ongoing maintenance of the stormwater management system	4	2	4	4	4	4	**22**
R1.6: Conduct a study to identify options for improved management of stormwater in the valley bottom, considering the potential for extreme rainfall events to occur during times of high groundwater levels, and winter drainage issues	4	2	3	4	4	4	**21**
R1.7: Update IDF curves to reflect current and projected precipitation patterns, incorporating climate change	3	2	3	4	4	3	**19**
R1.8: Strengthen the Engineering Design and Construction Guidelines and Land Use Bylaw to include new techniques and requirements for on-site storm water retention and management	3	4	4	2	2	3	**18**
R7: Water supply shortage							
R7.1: Monitor and evaluate water pricing rates and structures for residential and commercial users annually or as required to ensure water conservation is encouraged	3	4	4	4	4	4	**23**
R7.2: Renew the TransAlta agreement to require adequate water supply from the Rundle Forebay surface water treatment plant	4	4	4	3	4	4	**23**
R7.3: Develop a Water Shortage Response Plan	4	3	4	4	4	4	**23**
R7.4: Provide additional budget and resources to support expanded implementation of the leak detection and repair program	3	3	4	4	4	4	**22**
R7.5: Expand communications related to water conservation and efficiency aspects of the Environmental Sustainability Action Plan	3	3	4	4	4	4	**22**
R7.6: Re-introduce a grant/rebate program for property-level water conservation and efficiency upgrades and expand scope of measures offered	3	2	4	3	4	4	**20**
R7.7: Review and update the Utilities Master Plan to include the potential impacts of climate change on local water supply and demand, and the consideration of compound risks, such as low flow / water levels and pump failures at reservoir	3	2	3	4	4	4	**20**

ACTION	Effectiveness	Affordability	Feasibility	Acceptability	Equitability	Flexibility	TOTAL
R13: Heavy snow event, blizzard							
R13.1: Increase the public's awareness of their responsibilities for snow and ice removal within the Traffic and Road Use Bylaw	3	4	4	4	4	4	**23**
R13.2: Modify existing rules for prioritizing sidewalks for snow and ice clearance to include public safety parameters linked with heavy snowfall events (including accounting for the vulnerability of specific user groups, like the elderly)	3	4	4	4	4	4	**23**
R13.3: Conduct a simple snow load risk assessment of municipal facilities to determine high risk facilities and help prioritize snow clearing and maintenance operations	3	3	4	4	4	4	**22**
R13.4: Increase the availability of tools and equipment for site-specific snow clearing at municipal facilities through the purchase of additional equipment and / or more efficient use / sharing of existing of equipment	3	3	4	4	4	4	**22**
R13.5: Adjust operational snow and ice clearing procedures to better manage heavy snow loads and freeze-thaw cycles, including clearing and off-site storage of snow to reduce risk of ice build-up on sidewalks and trails	3	3	2	4	4	4	**20**
R13.6: Install power surge protection and back-up power sources at priority municipal facilities (beyond critical facilities)	3	1	4	4	4	4	**20**
R13.7: Conduct a hazard assessment (including snow load and wind risk) as part of the urban forest management plan to identify and remove hazardous trees across the community	3	2	4	2	4	3	**18**
R13.8: Develop an internal policy to exceed the snow load design requirements in the Alberta Building Code for new municipal developments and large renovation projects	4	2	2	1	3	3	**15**
R13.9: Bury power lines underground in areas where overhead lines are vulnerable to extreme wind and snow loading	3	1	3	4	3	1	**15**
R6: Extreme wind storm							
R6.1: Strengthen the event permitting process requiring applicants to specifically address the risk of extreme wind storms in Emergency Response Plans	2	4	4	4	4	4	**22**
R14: Freeze-thaw cycle							
R14.1: Improve coordination between the Engineering, Public Works and Planning & Development regarding planning and design of new roads and sidewalks, and upgrades to existing roads and sidewalks	2	4	4	4	4	4	**22**
R14.2: Improve processes to ensure utility cuts are properly rehabilitated and consider permit fees to offset road rehabilitation costs	2	4	4	4	4	4	**22**
R14.3: Enhance the pavement management strategy by focusing on preventative maintenance, researching and utilizing better asphalt mixes and road structures, including collaboration with City of Calgary, and including links to the internal log of crack sealing and pot hole work	3	3	3	4	4	4	**21**
R14.4: Strengthen the Engineering Design and Construction Guidelines to identify and map frost susceptible soils and better address freeze-thaw impacts such as requiring the use of native (granular) materials	3	3	3	2	3	4	**18**
O1: Increase in summer recreation opportunities							

ACTION	Effectiveness	Affordability	Feasibility	Acceptability	Equitability	Flexibility	TOTAL
O1.1: Increase promotion of Canmore as a bike friendly community / leading bike destination	3	3	4	4	4	4	**22**
O1.2: Promote and support additional community and cultural events (e.g. music, food, etc.) in extended shoulder seasons and to coincide with additional sporting events at Nordic Center	3	3	4	4	4	4	**22**
O1.3: Promote and provide additional support to expand local Roam bus service (e.g., subsidized fares for defined introductory period)	3	2	4	4	4	4	**21**
O1.4: Expand and enhance facilities and infrastructure that support summer and shoulder season activities such as running, hiking, biking and fat biking (which is less vulnerable to climate variability), including development of a destination hiking trail, promotion of in-town trails, and expansion of fat biking trails in winter	3	2	4	3	3	3	**18**
O5: Increase in winter tourism competitive advantage							
O5.1: Monitor and adapt snow making and storage program as climate changes to continue to provide early season (Oct-Nov) training facilities for nordic athletes from across the globe	3	3	4	4	4	4	**22**

ALL ONE SKY FOUNDATION is a not-for-profit, charitable organization established in 2010 to help vulnerable populations at the crossroads of energy and climate change. We do this through education, research and community-led programs, focusing our efforts on adaptation to climate change and energy poverty. Our vision is a society in which ALL people can afford the energy they require to live in warm, comfortable homes, in communities that are able to respond and adapt to a changing climate.

www.allonesky.ca

Email: helen@allonesky.ca
Phone: 403.471.6247

809 49th Ave SW, PO Box 19012, Calgary, AB., T2S 1A0, Canada