TOWN OF BANFF

CLIMATE RESILIENCE ACTION PLAN

March 2016

*"A resilient [*community*] is one that has developed capacities to help absorb future shocks and stresses to its social, economic, and technical systems and infrastructures so as to still be able to maintain essentially the same functions, structures, systems, and identity."*

[Working Definition, ResilientCity.org]

This Climate Resilience Action Plan (Action Plan) has been produced through the **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.

The goal of Climate Resilience Express is to produce a streamlined ("express") process for developing a climate resilience action plan for smaller communities through a one-day workshop process, and to subsequently prepare a 'self-help' toolkit to support these communities in working through the process. Four smaller communities from across Alberta were selected to pilot the workshop process and aspects of the toolkit. The Town of Banff, in collaboration with the Town of Canmore, was one of the selected communities.

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.

March 2016

Summary

The effects of climate change are already apparent in the Banff area, with observable changes in temperature, precipitation, and extreme weather events over the last century. The impacts of climate change could be numerous and diverse, giving rise to uncertain consequences, for infrastructure and services, property, the local economy and environment, and the health and well-being of citizens. To better prepare for these potential impacts, the Town has prepared this Action Plan which identifies a number of anticipatory measures to manage priority threats and opportunities expected to result from climate change over the next several decades.

In total nine climate-related risks, and four climate-related opportunities were identified, of which one risks – wildfire, was judged to be a priority requiring immediate action and is the focus of this Action Plan.

The Town of Banff is already committed to numerous actions that help manage wildfire risk, including: amendments to the Land Use Bylaw to incorporate Firesmart principles; a tactical wildfire response plan; a community Firesmart education program; joint training exercises with partner agencies; forest fuel thinning on lands within and around the community; and a Municipal Emergency Plan with protocols for community notification & evacuation in the event of a wildfire.

In addition to existing actions that help mitigate priority climate risks, eight actions are identified for implementation to help Banff better prepare for climate change. A number of actions can be implemented quickly with minimal investment, whereas other actions have longer-term timeframes and require a higher level of investment. Implementation of these actions, and actions to address other key risks in Banff, will ensure that the Town remains resilient under a wider range of potential future climate conditions.

This Action Plan is a living document and should be periodically reviewed and updated to ensure it remains relevant and effective.

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1. Introduction

The effects of climate change are already apparent in Banff, 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 +1.4°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 takes a while to respond. How much the climate will change beyond the next few decades depends on how far 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 will 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 lifestyles of citizens. Potential impacts may include 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 communities 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 the population lives, works and raises families. Smaller communities with limited resources are particularly vulnerable and may lack the capacity to adequately respond to increasing impacts. It is therefore essential that communities 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 Banff, through the preparation of this Action Plan, is taking steps towards a safe, prosperous and resilient future. The Action Plan identifies a number of anticipatory measures to manage priority risks and opportunities anticipated to result from climate change in the area over the next several decades.

2. DEVELOPING THE ACTION PLAN

The overall approach to developing climate resilience action plans through Climate Resilience Express 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 climate resilience action planning;

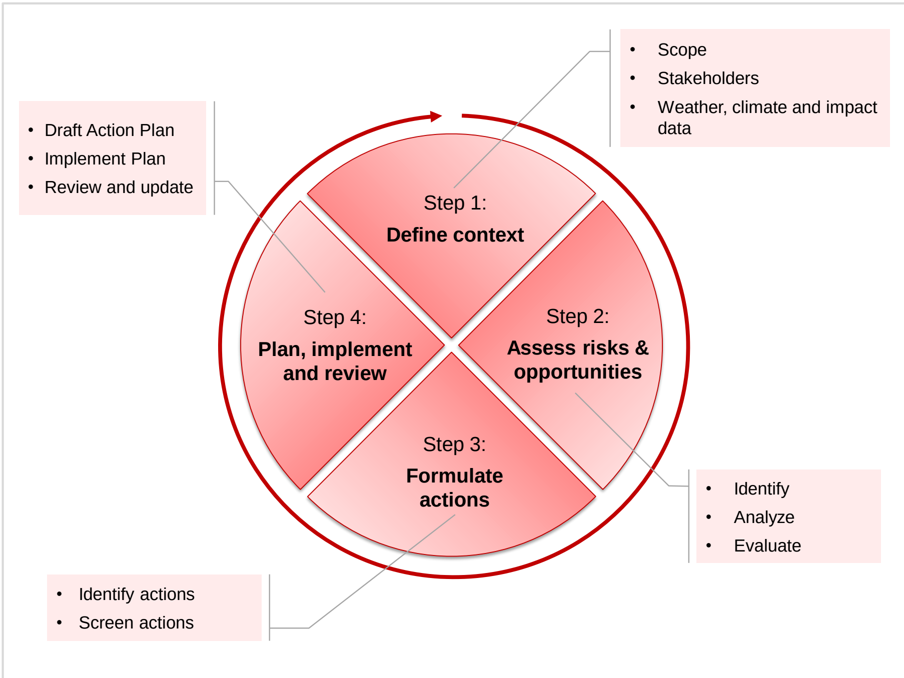
Step 2: Assess potential climate-related risks and opportunities to establish priorities for action;

Step 3: Formulate actions to manage priority risks and opportunities; and

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

Step 2 and Step 3 of the process are the focus of the one-day workshop with local stakeholders, which is at the heart of Climate Resilience Express. Step 1 is undertaken in advance of the workshop; preparing the Action Plan and Step 4 takes place after the workshop.

Figure 1: Climate Resilience Express — action planning process



BEFORE THE WORKSHOP: STEP 1

Prior to the workshop the context for climate resilience action planning in Banff is established. This involves:

- **Defining the spatial scope**

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

- **Defining the operational scope**

  The assessment of risks and opportunities considers potential community-wide impacts, which includes 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 considers impacts arising from projected climate and associated environmental changes out to the 2050s. 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 functional life of key public infrastructure investments and strategic land-use planning and development decisions.

- **Compiling climate and impact data**

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

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

  Scales are required to establish the relative severity of impacts in order to determine priorities for action. The scales used in the risk and opportunity assessment at the workshop are provided in Appendices.

AT THE WORKSHOP: STEP 2 AND STEP 3

The one-day workshop used to generate the information underpinning this Action Plan comprises four main sessions. Workshop participants are listed in Appendix A.

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

  The session objective is to explore the relationship between weather, climate and key aspects of Banff in relation to past weather-related impacts. Outcomes from this session at the workshop are presented in Section 3.

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

  The session objective is to present information about climate science, local climate trends and projections, projected environmental changes, and potential impacts for the area. This information is also presented in Section 3.

- **Session 3: Assess future risks and opportunities**

  The session objective is twofold; first, to determine how projected climate or environmental changes could impact the Bow Valley Corridor, and second, to prioritize the identified impacts in order to establish priorities for action planning. The prioritization of impacts involved reviewing and modifying the list, retaining only those impacts specifically relevant to Banff. Outcomes from this session at the workshop are presented in Section 4.

- **Session 4: Action planning**

  The session objective is to determine what actions are necessary to increase resilience to priority risks and to capitalize on priority opportunities. Outcomes from this session at the workshop are presented in Section 5.

AFTER THE WORKSHOP: STEP 4

Outcomes from the workshop are used as the basis for this Action Plan. Building resilience to climate change is not a static process, however, but rather needs to be monitored and reviewed to both check progress on implementation and to take account of changing scientific knowledge about the physical impacts of climate change. Implementing this Action Plan, reviewing progress, and updating the Plan to keep it relevant are discussed in Section 6.

3. Observed Impacts, Climate Trends and Projections

Observed Local Weather and Climate Impacts

Session 1 at the workshop 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 residents' health and lifestyles. A selection of observed weather-related impacts on the community 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, notable 2013 caused significant community-wide impacts, particularly in Canmore
- ✓ Warmer winters with less snow impact winter tourism such as ski areas and dog sledding
- ✓ Freeze/thaw cycles negatively impact roads and sidewalks and have led to transportation disruptions
- ✓ Wildlife habitat and migration impacted by long-term changes in temperature and seasonality
- ✓ Tourist season extending longer into the fall
- ✓ Reduced river flows increase stream temperatures and affect water supply and recreation
- ✓ Pest infestations such as mountain pine beetle
- ✓ More ticks and longer season
- ✓ Change in allergy season – longer and different
- ✓ Reduced snowpack over season
- ✓ Glacier recession on icefields is noticeable
- ✓ Excessive precipitation in short duration overwhelms stormwater system
- ✓ More extreme weather – heat, wind, hail, thunderstorms
- ✓ Longer growing season for community gardens

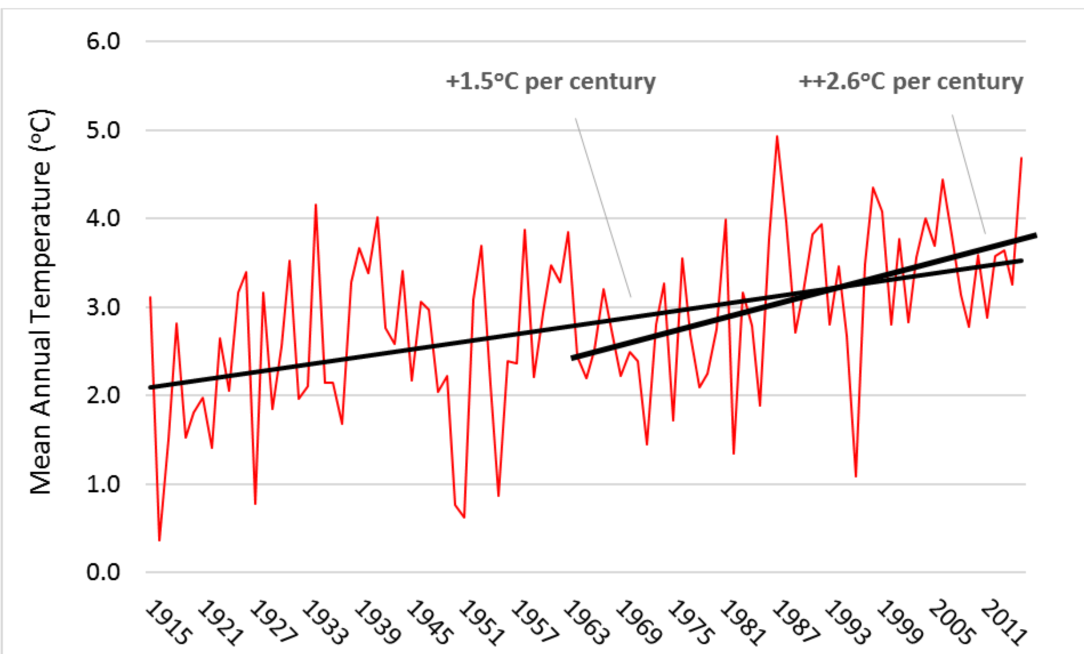
LOCAL CLIMATE TRENDS

To provide a perspective of historic climate trends in the Bow Valley Corridor, data is collected and analyzed from six climate stations in the region (Golden, Lake Louise, Banff, Kananaskis, Calgary and Olds)[i]. 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 of temperature and precipitation for the Bow Valley Corridor are assembled by averaging the individual records from the five climate stations and applying appropriate statistical techniques[ii].

➡ **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.

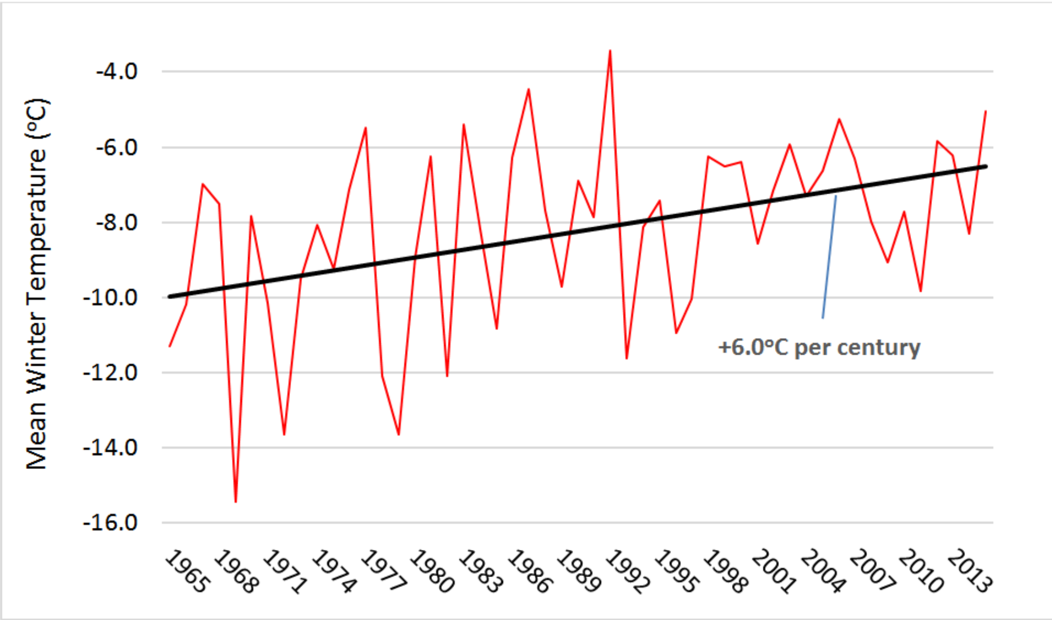
Figure 2: Mean annual temperature in the Bow Valley Corridor (1915-2015 and 196-2015)



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), which is substantially greater than the annual rate of

+2.6°C per century. In contrast, warming during the summer (June-August) since 1965 increased at a slower rate of +1.9°C per century. Trends in mean spring and fall temperature are also positive over the last 50 years.

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 significantly 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 and 196-2015)

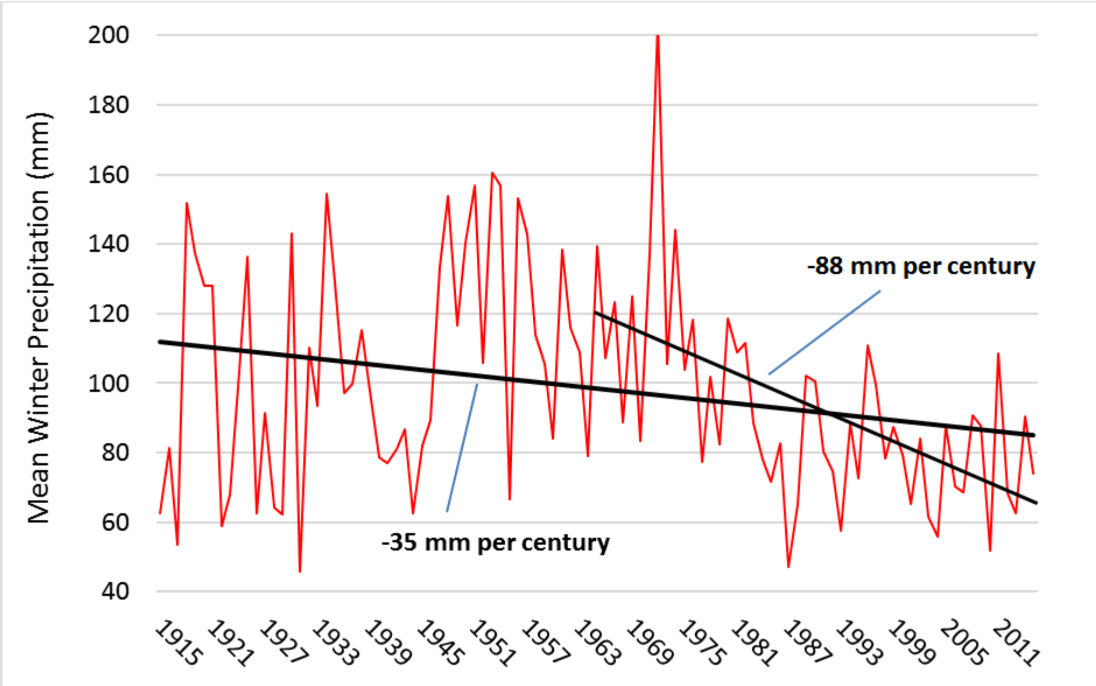
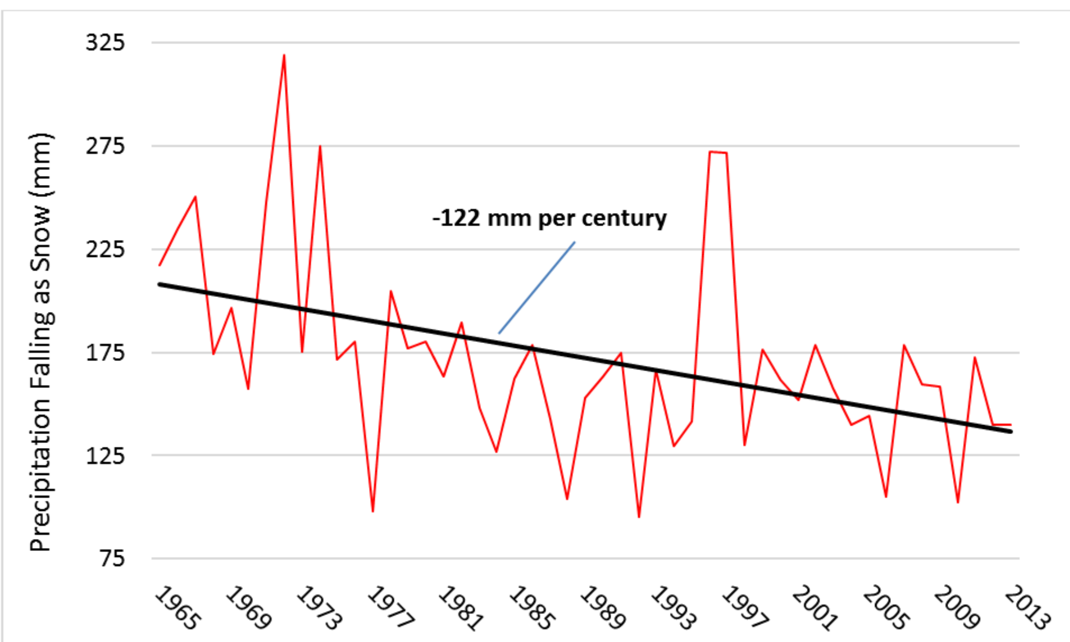


Figure 5: Mean annual precipitation falling as snow (1965-2015)



Source: CWNA[iii]

CLIMATE PROJECTIONS FOR AREA

Climate projections for the Bow Valley Corridor, for the 2050s, were derived using the Pacific Climate Impacts Consortium's (PCIC) Regional Analysis Tool[iv]. 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." [v]

Climate projections for the 2050s in the Bow Valley Corridor 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 in the 2050s to about 4.7ºC. This projected increase in temperature is consistent with the rate of change in mean annual temperature that has been observed in the Banff area 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%.

Table 1: Summary of climate projections for 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.

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.

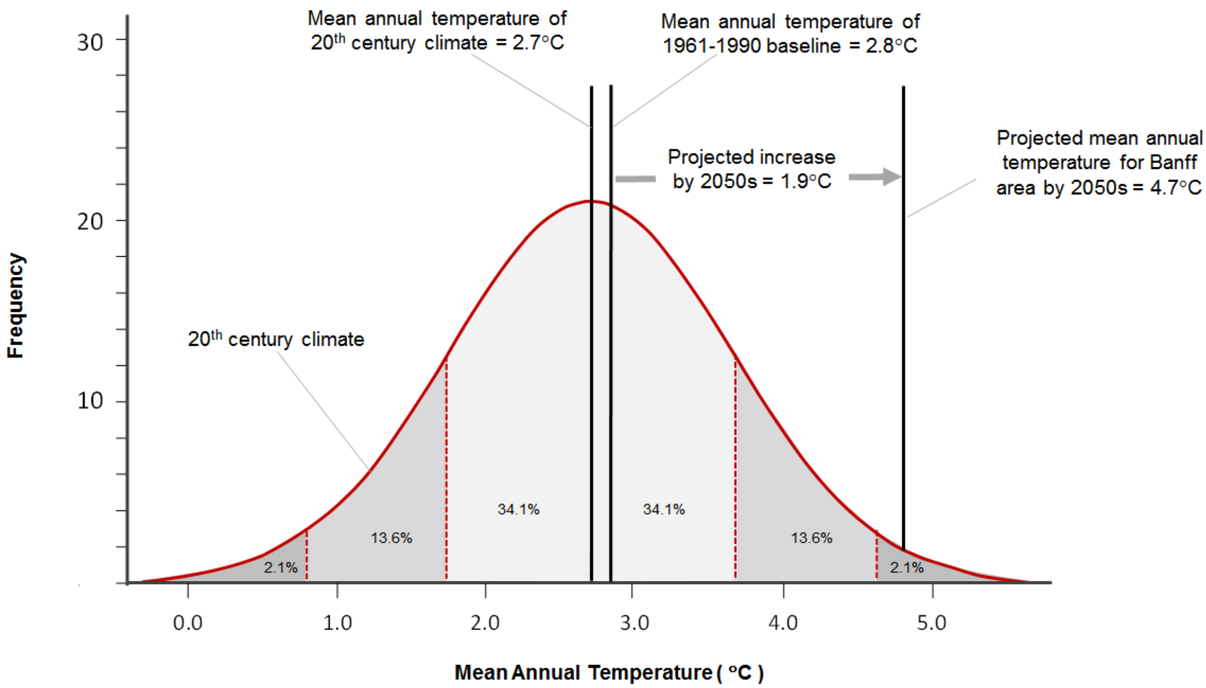
- **Precipitation extremes**

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[vi]. 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[vii]. 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.

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, a normal distribution (bell curve) was fitted to the 20th century climate of the Bow Valley Corridor (1914-1999). 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 Bow Valley climate over the period 1961-1990 with that of Brooks, Alberta.



PROJECTED ENVIRONMENTAL CHANGES

Projected changes in average temperature and precipitation in the Bow Valley Corridor will have broad consequences across the natural environment, including for moisture availability, growing season, regional ecosystems, invasive plants, streamflow, wetlands, and wildfires.

➡ 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[viii] . Over the course of twenty years, between 1985 and 2005, glaciers in Alberta lost approximately 25% of their area[ix] (e.g., Figure 6). 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[x] (Figure 7).

➡ Snowpack

The projected winter and spring warming and reduced precipitation falling as snow in the winter months will affect snowpack in the Rocky Mountains[xi,xii]. In the Bow Valley Corridor, average daily snow depth at 1600m 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[xiii] .

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

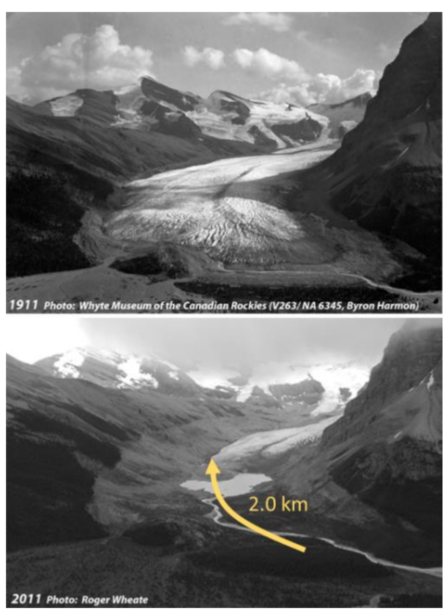


Figure 7: Projected glacier ice area in the Canadian Rockies, relative to 2005[xiv]

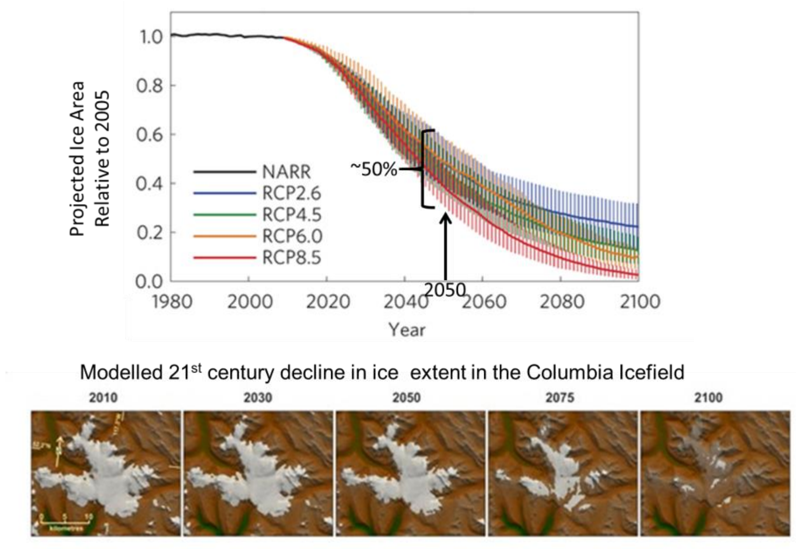
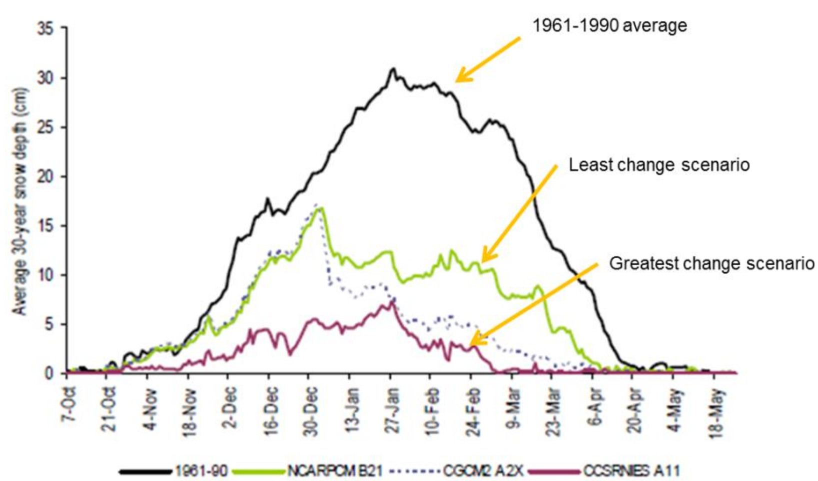


Figure 8: Projected daily average snow depth at Banff (1600m elevation) in the 2050s[xv]



➡ **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[xvi]. Warmer winter temperatures, an increased proportion of rain versus snow in winter months, and earlier snowmelt will all influence streamflow in the rivers and creeks in the region[xvii]. Streamflow is projected to increase in winter, peak earlier in the spring, and decrease in the summer[xviii]. Meltwater from glacial sources will become increasingly less reliable in the future as glaciers in the eastern Rockies continue to melt[xix]. Stream temperatures in the region are projected to increase during the summer months, as a result of projected warming[xx], with potential consequences for aquatic wildlife habitats and recreation opportunities[xxi].

➡ 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[xxii, xxiii].

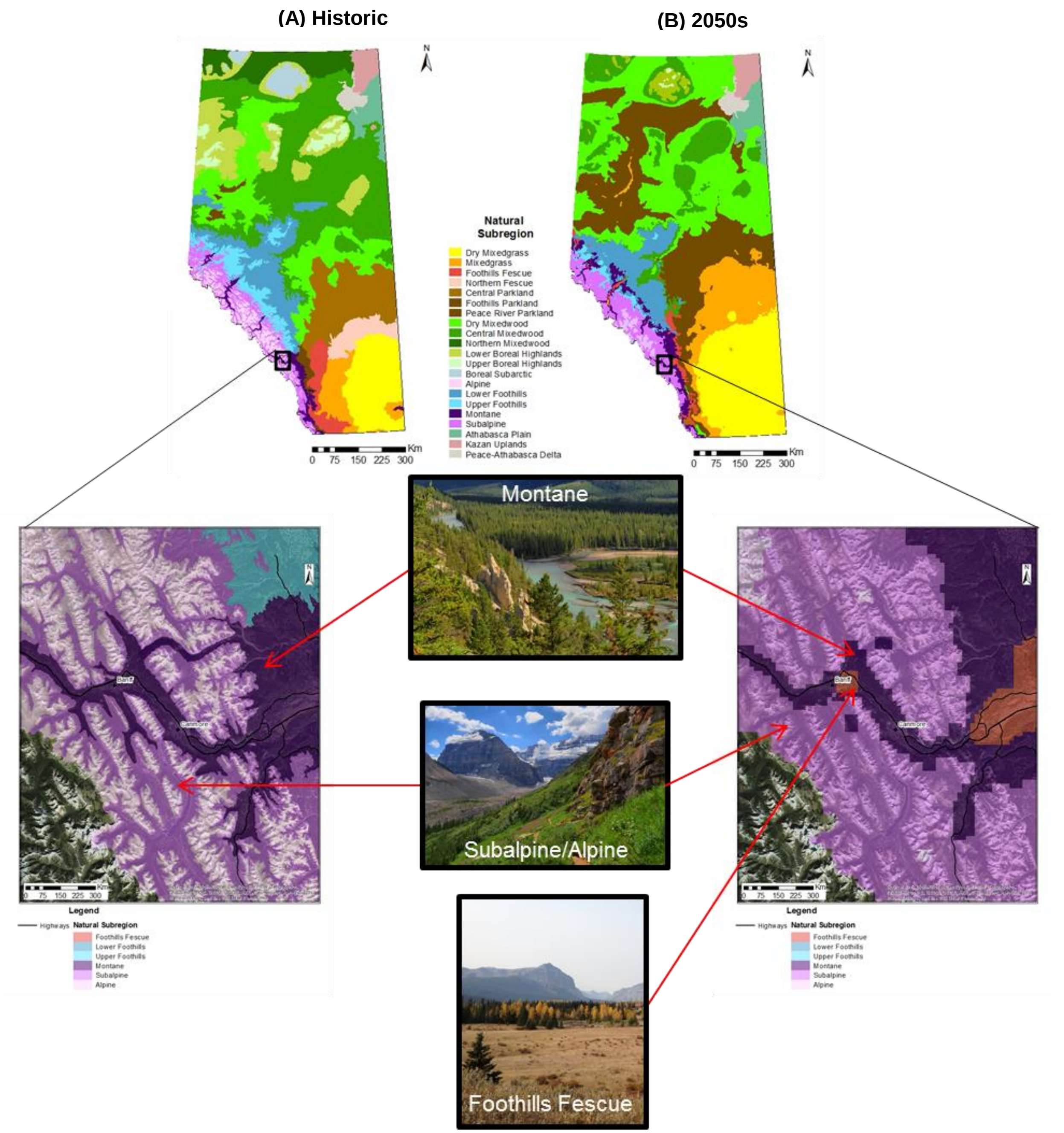
Climate change will also likely favour insect pests, like mountain pine beetle, whose populations will benefit from warming conditions that increase overwinter survival and promote faster generation times[xxiv,xxv].

➡ 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 Banff 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[xxvi]. 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 [xxvii] (see Figure 9).

The warmer and drier conditions projected for the Banff 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)[xxviii]. 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[xxix]. 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[xxx].

Figure 9: (A) Historic (1961-1990) and (B) projected (2050s) distribution of natural sub-regions in Alberta and in the Bow Valley Corridor[xxxi,xxxii]



4. Climate Risks and Opportunities for Banff

Session 3 at the workshop invited participants to:

1. Identify how projected climate or environmental changes for the 2050s could impact the Bow Valley Corridor; and

2. Translate the identified impacts into risks and opportunities in order to establish priorities for action planning.

Potential Climate Impacts

Workshop participants identified a range of climate-related impacts for the local economy, property and infrastructure, the natural environment, and residents' health and lifestyles. The list of identified impacts is provided in Table 2.

Table 2: Potential climate change impacts with mainly negative (-) or positive (+) consequences for the Bow Valley Corridor

Stormwater system overwhelmed, localized flooding (-)	Decline in winter tourism and recreation (-)
Increased avalanche risk (-)	Adverse impacts on fish and aquatic ecosystem from changes in stream flow timing and volume (-)
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 (+)

PRIORITY CLIMATE RISK AND OPPORTUNITIES

The potential impacts listed in Table 2 served as a starting point for the risk and opportunity assessment. Following plenary discussion at the workshop, some impacts were merged and the descriptions modified. Other impacts were deemed not particularly relevant to Banff, or had positive and negative consequences that were judged to cancel each other out; these were not considered further. This produced a smaller list of the most important potential impacts for Banff.

Workshop participants were invited to translate these impacts into risks (impacts with mainly negative consequences) and opportunities (impacts with mainly positive consequences), and to simultaneously prioritize the risks and opportunities. Priorities are assigned to impacts by scoring, first, the severity of potential consequences for the area, and second, the likelihood of those consequences being realized. Participants assigned scores to impacts using the consequence scales found at Appendix B (for risks) and Appendix C (for opportunities), and the likelihood scale found at Appendix D.

➡ Potential risks

Table 3 provides a description of the potential climate change risks facing the Town of Banff. The description includes a selection of key consequences, along with the label used to identify the impact in the “risk map” shown in Figure 10. The risk map is a two-dimensional representation of adverse consequences plotted against likelihood. Impacts in the upper right corner of the map have larger adverse consequences combined with a high likelihood of occurrence. These impacts are priorities for action.

Table 3: Climate change risks facing Banff by the 2050s

Potential local risks		Key consequences for Banff
Label for risk map	Description	
"Flooding"	Flooding of Bow River caused by an increase in the number of extreme precipitation events, earlier peak stream flow, more spring precipitation as rain	• Public health and safety, including stress and anxiety • Disruption to economic activities, loss of output • Tax increases required to mitigate risk • Damage to, loss of, property and infrastructure • Interruption to lifelines (power, water, sewer) • Demands on emergency services, cost to town • Evacuations • Damage to wildlife habitat, bank erosion
"Hail storm"	Hail storm event caused by an increase in the intensity of summer storms	• Public safety • Increased use of indoor recreation facilities • Damage to property (buildings, gardens, vehicles, etc.) and infrastructure • Interruption to lifelines (power, communications)
"Impact on aquatic species"	Negative impacts on fish and aquatic ecosystems from earlier spring peak flow, decreased flow in summer and warmer waters	• Decline in recreational fishing • Loss of jobs and economic output for select businesses (fishing guides) • Potential decline in fish stock and reduction in food for other wildlife
"Lightning"	Lightning storm event caused by an increase in the intensity of summer storms	• Public safety • Disruption to economic activity (power outages) • Damaged trees • Interruption to lifelines (power)
"Reduction in glacier-based summer tourism"	Potential reduction summer tourism activities focused on glaciers, resulting from less precipitation as snow and glacial recession	• Job losses for select regional businesses • Reduced tourism expenditures
"Reduced winter tourism"	Decline in winter recreational opportunities for locals and tourists resulting from less precipitation falling as snow, warmer winter temperatures and reduced winter snowpack	• Stress and anxiety, decline in quality of life, grumpy people • Decline in economic output and job losses for tourism businesses • Potential reduction in property values due to out migration • Reduced reputation/ perception of town

Potential local risks		Key consequences for Banff
Label for risk map	Description	
"Stormwater infrastructure overwhelmed"	Stormwater system overwhelmed, and localized flooding, due to an increase in extreme precipitation events	• Transport disruption – inconvenience, delay of supplies, products • Disruption to economic activities, loss of output • Damage to property and infrastructure • Interruption to lifelines (water, sewer) • Increased repair and maintenance costs • Outdated stormwater design and landscaping standards
"Water supply shortage"	Inability to meet water demand of town due to warmer summer temperatures, less summer precipitation, reduced extent of glaciers and less precipitation as snow (reduced water towers)	• Inconvenience (water bans) • Deterioration in water-based recreation • Decline in economic output, selected businesses • Deterioration in water quality, aquatic ecosystem • Interruption to lifelines (water supply) • Costs to town (water treatment)
"Wildfire"	Increased interface wildfire risk caused by increased summer temperatures and heat waves, less precipitation in summer, less available moisture and a longer fire season.	• Public safety risk from smoke inhalation, poor air quality • Loss of visual amenity - reduced tourism visits • Decline in economic output (reduction in tourists) • Damage to, loss of, trees and other wildlife habitat and ecosystems • Damage to property and infrastructure • Interruption to lifelines (power, communications) • Demands on emergency services, costs to town

Figure 10: Risk map for climate change impacts facing Banff

CONSEQUENCES						
	(5) Major				Wildfire	Higher priorities for action
	(4)	Water supply shortage				
	(3) Moderate		Wind storm Stormwater infrastructure overwhelmed	Flooding Hail storm Lightning	Reduced winter tourism	
	(2)			Reduction in glacier-based tourism Impact on aquatic species		
	(1) Negligible	Lower priorities for action				
		(1) Low	(2) Low-moderate	(3) Moderate	(4) Moderate-high	(5) High
		LIKELIHOOD				

Impacts in the red and yellow zones are priorities for further investigation or management. Impacts in the red zone are the highest priorities for action. Impacts in the green zone represent broadly acceptable risks; no action is required now for these impacts beyond monitoring of the risk level as part of periodic reviews (see Section 6).

Potential Opportunities

Table 4 provides a description of the potential climate change opportunities for Banff. The description includes a selection of potential benefits, along with the label used to identify the impact in the opportunity map shown in Figure 11. Impacts in the upper right corner of the map have greater potential benefits combined with a high likelihood of occurrence. These impacts are priorities for action.

Table 4: Climate change opportunities for Banff by the 2050s

Potential local opportunities		Key consequences for Banff
Label for opportunity map	Description	
"Increase in winter tourism"	Increase in high elevation winter tourism, namely alpine skiing, relative to other winter tourism destinations	• Increase in local sales for tourism businesses • More jobs
"Increase in shoulder season tourism"	Extension of should season tourism into spring and fall, due to warmer spring and fall temperatures and reduced winter snowpack	• Recreation / amenity benefits for residents – increased walking and biking options • Increase in local sales for tourism businesses • More jobs
"Increase in summer season tourism"	Increase in summer tourism from warmer summer temperatures	• Recreation / amenity benefits for residents – increased walking and biking options • Increase in local sales for tourism businesses • More jobs
"New growing opportunities"	Increase in home gardening opportunities as a result of warmer temperatures in spring and summer	• Increased local food availability • Improved quality of life

Figure 11: Opportunity map for climate change impacts facing Banff

CONSEQUENCES						
	(5) Major					Higher priorities for action
	(4)				Increase in shoulder season tourism	
	(3) Moderate		Increase in summer season tourism	Increase in winter tourism		
	(2)			New growing opportunities		
	(1) Negligible	Lower priorities for action				
		(1) Low	(2)	(3) Moderate	(4)	(5) High
		LIKELIHOOD				

Impacts in the dark blue and light blue zones are priorities for further investigation or promotion. Impacts in the dark blue zone are the highest priorities for action. Impacts in the grey zone represent marginal opportunities; no action is required now for these impacts beyond monitoring of the level of opportunity as part of periodic reviews (see Section 6).

5. Climate Resilience Actions

The next step is to formulate actions (a) to increase resilience to priority risks and (b) to increase capacity to capitalize on priority opportunities.

For the priority risks and opportunities plotted in Figure 10 and Figure 11 respectively, Session 4 at the workshop invited participants to devise a list of recommended adaptation actions. . Ideally, actions should be devised for all priority risks and opportunities. However, within the time constraints of the one-day workshop used by Climate Resilience Express, action planning focuses on a subset of priority risks and opportunities, chosen by workshop participants. However, due to a combination of limited participation at this session, which meant the necessary local expertise was not present, and the need to end the workshop early, it was only possible to begin the process of action planning for one priority risk: wildfire.

In general, for each priority risk and opportunity a starter action plan is developed by, first, addressing the following two questions:

1. What actions are currently being taken to manage the risk or opportunity?
2. What new actions, or improvements to existing actions, are needed to more effectively manage the risk or opportunity in the future?

The resulting long-list of potential actions is screened to identify, for each priority risk or opportunity, three to five of the most promising actions for inclusion in the climate resilience plan. When screening actions, participants should consider • the likely effectiveness of the action in mitigating the risk, • how feasible it would be to implement, • how generally acceptable it would be to stakeholders, including elected officials, and • how equitably spread are the costs and benefits of the action across the community.

To support the successful implementation of recommended actions, workshop participants also provided information on:

1. Total implementation costs;
2. The timeframe for implementation; and
3. The lead department or organization.

These three factors are key inputs to the development of an implementation strategy. Table 5 is used to help participants provide approximations for (1) and (2).

Table 5: Climate resilience actions – definitions for total implementation costs and implementation timeframe

Information	Descriptor	Description
Total implementation costs	Low	Under $10,000
	Moderate	$10,000 to $49,999
	High	$50,000 - $99,999
	Very high	$100,000 or more
Timeframe to have action implemented (operational)	Ongoing	Continuous implementation
	Near-term	Under 2 years
	Short-term	2 to 5 years
	Medium-term	5 to 10 years
	Long-term	10 years or more

The beginnings of a starter action plan for future wildfire risk in Banff are provided below. The new actions listed still need to be screened and relevant information collated to support implementation (Section 6)

It is important that all the priority risks and opportunities contained in Figure 10 and Figure 11, respectively, are put through the full action planning exercise outlined above as soon as it is practical to do so.

WILDFIRE

The Town of Banff is already committed to numerous actions that will help manage wildfire risks. Some of these actions were identified during Session 5 of the workshop and include:

- The Land Use Bylaw was recently amended to incorporate Firesmart principles, and includes identification of high risk fire zones and requirements for fireproof roofing materials in those zones;
- A robust tactical response plan is in place for wildfire response and includes (map out hydrants, hose size);
- Adequate water supply for firefighting has been identified and is readily available to combat wildfires;
- The town conducts Firesmart education across the community;
- Joint training exercises have been completed with partner agencies (Parks Canada and Alberta Environment and Parks)
- The Town has a significant amount of structural protection equipment, including equipment specific to wildland fire fighting;

- Forest fuel thinning has occurred on lands within and around the community;
- The Municipal Emergency Plan includes protocols for community notification & evacuation; and
- The Town has a Community champion program under development to support Firesmart activities on private property.

It is important that the Town continue to support the implementation of these important climate resilience activities.

In addition to the current actions above, a variety of additional or improved actions were identified to ensure the Town of Banff remains resilient to wildfire risk in the future:

- Increase community education efforts around the need to protect buildings, property and infrastructure from wildfire;
- Update municipal landscaping standards to include requirements for planting fire resistant tree species;
- Purchase additional structural protection equipment to improve the Town's ability to protect buildings, property and infrastructure from wildfire;
- Ensure all pumping stations for wildfire water supply are pre-wired for generator backup;
- Work with Parks Canada to conduct additional prescribed burns on lands adjacent the community;
- Enhance interface fuel reduction and management efforts;
- Update the Land Use Bylaw to include incentives for homeowners and developers to utilize Firesmart principles; and
- Work with Parks Canada to enhance wildfire forecasting, smoke modelling and fire hazard rating.

6. Implementation and Next Steps

> Writing a plan and leaving it on the shelf is as bad as not writing the plan at all. If this Action Plan is to be an effective tool, it must be implemented and reviewed periodically.

Acting

The recommended actions listed in Section 5 serve as a 'shopping-list'. Town staff 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. Community outreach, for example through the Town website or at public events 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 become more resilient.

Mainstreaming

This Action Plan is developed as a 'stand-alone' document. However, it is important that climate resilience generally is integrated (i.e., 'mainstreamed')—as a matter of routine—into the Town's 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 and neighborhood scale plans should consider potential future climate change impacts; and

- Decisions related to the design, maintenance, and upgrading of long-life infrastructure 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 the first step in Banff'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.

7. APPENDICES

Appendix A: Workshop participants

Name	Title
Town of Banff Participants	
Participant list unavailable	
Town of Canmore Participants (Sessions 1-3 only)	
Greg Burt	Manager of Protective Services, Town of Canmore
Felix Camire	Project Engineer, Town of Canmore
Andreas Comeau	Manager of Public Works, Town of Canmore
Natalie Cooper	Environmental Advisory Review Committee member
Alaric Fish	Manager of Planning and Development, Town of Canmore
Stephen Hanus	Manager of Facilities, Town of Canmore
Brian Kinzie	Development Project Engineer, Town of Canmore
Laura Lynes	The Rockies Institute
Matthew McCrank	Epcor Manager, Canmore
Serge Metikosh	Environmental Advisory Review Committee member
Ron Remple	Executive Director Bow Valley Builders and Developers Association; also represents Canmore Business and Tourism
David Reynolds	
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
Vi Sandford	Councillor, Town of Canmore
Mark Storie	Kananaskis Regional Director, Alberta Environment and Parks

Appendix B: Scale for scoring the consequences of risks

Score	Description
(1) **Negligible**	• Negligible impact on health & safety and quality of life for residents • Very minimal impact on local economy • Insignificant environmental disruption or damage • Slight damage to property and infrastructure, very short-term interruption of lifelines, or negligible cost to municipality
(2)	
(3) **Moderate**	• Some injuries, or modest temporary impact on quality of life for some residents • Temporary impact on income and employment for a few businesses, or modest costs and disruption to a few businesses • Isolated but reversible damage to wildlife, habitat or and ecosystems, or short-term disruption to environmental amenities • Damage to property and infrastructure (including critical facilities and lifelines), short-term interruption of lifelines to part of community, localized evacuations, or modest costs to municipality
(4)	
(5) **Major**	• Many serious injuries or illnesses, some fatalities, or long-term impact on quality of life for most residents • Long-term impact on businesses and economic sectors, major economic costs or disruption • Widespread and irreversible damage to wildlife, habitat and ecosystems, or long-term damage, disruption to environmental amenities • Widespread damage to property & infrastructure (including critical facilities and lifelines), extensive and long-term interruption of services, widespread evacuations, or major cost to municipality

Appendix C: Scale for scoring the consequences of opportunities

Rating	Description
(1) **Low**	• Increase in income / jobs for a *few* businesses • Lifestyle improvement for *some* residents • Cost savings for municipality, businesses or residents
(2)	
(3) **Moderate**	• Increase in income / jobs for a *sector* • Lifestyle improvement for a *select group* of residents • Cost savings for municipality, businesses or residents • *Short-term* boost to reputation and image of municipality
(4)	
(5) **High**	• Increase in income / jobs for *key sectors* of local economy • Lifestyle improvement for a *majority* of residents • Cost savings for municipality, businesses or residents • *Long-term* boost to reputation of municipality

Appendix D: Scale for scoring 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

8. ENDNOTES

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[i] 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).

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[xiv] 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.

[xv] 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.

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[xxx] Photo credits (top to bottom): Janine Rietz, Janine Rietz, Emily Chow.