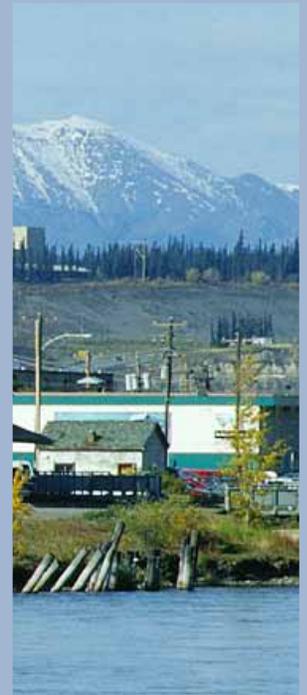


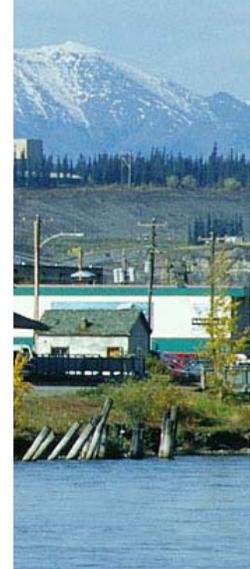
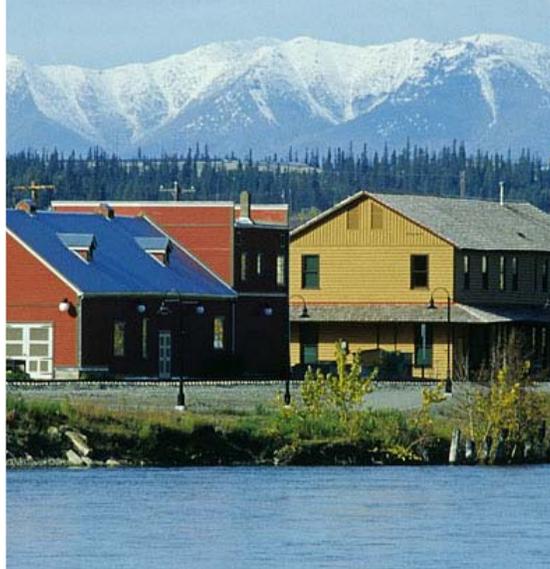
COMMUNITY ADAPTATION PROJECT



FUTURE HISTORIES OF WHITEHORSE: SCENARIOS OF CHANGE

September 2010

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FUTURE HISTORIES OF WHITEHORSE: SCENARIOS OF CHANGE

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We are especially grateful to all of the participants in this project for their enthusiasm and interest.

Whitehorse Scenarios Comparison Table

	 Scenario 1 City of Wilderness Some growth, some climate change	 Scenario 2 City of People Lots of growth, some climate change	 Scenario 3 City of Mettle Some growth, lots of climate change	 Scenario 4 City of Crossroads Lots of growth, lots of climate change
Whitehorse	<ul style="list-style-type: none"> + 6,000 people by 2030, + 12,000 people by 2050 public sector continues to dominate overall economic uncertainty has increased increased taxation 	<ul style="list-style-type: none"> + 12,000 people by 2030, + 25,000 people by 2050 growth in all areas of the city (mixed density) ratio of government to population normalizes increased % of population employed by resource, service, commercial & industrial sectors cost of living rises modestly Whitehorse becomes even more of a hub for communities 	<ul style="list-style-type: none"> + 6,000 people by 2030, + 12,000 people by 2050 forced densification across the city, especially in the downtown core median income declines private sector growth has remained sporadic and opportunistic cost of living increases private sector growth characterized by green industry 	<ul style="list-style-type: none"> + 12,000 people by 2030, + 25,000 people by 2050 growth mostly downtown higher turnover of population by 2050 mega-projects sparked growth in the private sector increased taxation median income decline issues outstrip any possible benefits from an improved economy of scale
Economy	<ul style="list-style-type: none"> public sector continues to dominate overall economic uncertainty has increased increased taxation 	<ul style="list-style-type: none"> ratio of government to population normalizes increased % of population employed by resource, service, commercial & industrial sectors cost of living rises modestly Whitehorse becomes even more of a hub for communities 	<ul style="list-style-type: none"> median income declines private sector growth has remained sporadic and opportunistic cost of living increases private sector growth characterized by green industry 	<ul style="list-style-type: none"> mega-projects sparked growth in the private sector increased taxation median income decline issues outstrip any possible benefits from an improved economy of scale
Climate	<ul style="list-style-type: none"> + 1°C by 2030 and + 2°C by 2050 winters will see more change with warming and variable snow 	<ul style="list-style-type: none"> + 1°C by 2030 and + 2°C by 2050 winters will see more change with warming and an increase in snow (several cm) 	<ul style="list-style-type: none"> + 2°C by 2030 and + 4°C by 2050 winters will see more change with warming and an increase in snow (10 cm) 	<ul style="list-style-type: none"> + 2°C by 2030 and + 4°C by 2050 winters will see more change with warming and an increase in snow (10 cm)

Whitehorse Scenarios Comparison Table, *continued*.

	Scenario 1 City of Wilderness Some growth, some climate change	Scenario 2 City of People Lots of growth, some climate change	Scenario 3 City of Mettle Some growth, lots of climate change	Scenario 4 City of Crossroads Lots of growth, lots of climate change
Environment	<ul style="list-style-type: none"> • biodiversity pressure from development • wetlands and waterways fragmented • increased precipitation and wetter conditions • moderate increase in forest fire risk • moderate increase in flood risk 	<ul style="list-style-type: none"> • biodiversity change due to development • water quality issues due to nitrification • increased precipitation and wetter conditions • severe fire risk due to sprawl • increased risk of landslides 	<ul style="list-style-type: none"> • more wind initially • more extreme weather, lightning and drought • more frequent freeze-thaw events • more frequent ice-jams • run-off and increased erosion • stressed species and spread of invasive species 	<ul style="list-style-type: none"> • more wind initially • more extreme weather, lightning and drought • more frequent freeze-thaw events • more frequent ice-jams • decreased water quality; stressed riparian systems • stressed species
Infrastructure	<ul style="list-style-type: none"> • public sector remains large • infrastructure strain proceeds as expected • institutional capacity is sufficient to compensate for changes 	<ul style="list-style-type: none"> • 2nd Yukon bridge built • increase in development • increased strain on infrastructure by population • highway washouts more common 	<ul style="list-style-type: none"> • compact development strategy • infrastructure ages normally • emphasis on green infrastructure development • increased emphasis on active transportation 	<ul style="list-style-type: none"> • increased strain on infrastructure by climate change and population • increased influence of 'multipliers' • opportunistic renewal/ replacement of infrastructure
Energy	<ul style="list-style-type: none"> • increase in energy-efficient housing • moderate sustainable development 	<ul style="list-style-type: none"> • rising oil and gas costs and continued dependency on fossil fuels • focus on biofuels to compensate for rising fuel costs 	<ul style="list-style-type: none"> • increased demand side management of energy • high sustainable development 	<ul style="list-style-type: none"> • rising oil and gas costs and continued dependency on fossil fuels • sustainable development strategies abandoned
Food Security	<ul style="list-style-type: none"> • slight increase in growing season • limited agriculture due to land use conflicts 	<ul style="list-style-type: none"> • reliability of outside food sources declines • agriculture supported by local institutions • population increase creates stable market 	<ul style="list-style-type: none"> • drought limits local food production • establishment of non-soil based food production program 	<ul style="list-style-type: none"> • local agriculture develops in an ad-hoc fashion with mixed success • global food shortages affect local food security • access to country foods limited

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INTRODUCTION

Climate change is an increasing concern for Yukon and its communities. Many observable changes have occurred across the Territory over the past fifty years, especially an increase in the annual temperature and precipitation of the Western Arctic (ACIA, 2004; Furgal and Prowse, 2008). The potential outcomes of changing climate have raised subsequent concerns for Yukon residents including a shifting distribution of country foods, the thaw of permafrost, changing landscape conditions, drought, and a host of other regional vulnerabilities. In response to this growing concern about climate change, the Northern Climate ExChange submitted a proposal to the Northern Strategy Trust in 2007 to develop and implement adaptation plans in three Yukon communities: Dawson, Whitehorse and Mayo. The Whitehorse Adaptation Project (WhiteCAP) began in June 2009 and brings together aspects of scenario planning and risk management to establish a process for adapting to climate change in the community.

Future Histories of Whitehorse: Scenarios for Change reports on the scenario planning component of the adaptation planning process. This report is intended to summarize our discussions with the community of Whitehorse on how the community may change over time and how residents might respond to that change. The range of possibilities provided by these multiple scenarios assists us with evaluating the uncertainty and variability associated with climate change and community development. While there is no one clear definition of scenario planning, the technique refers to the process of assessing a range of plausible future situations in order to make informed choices and decisions for present-day planning and development (Lindgren and Bandhold, 2003). The variables shaping these future scenarios include shifting demographic forces, sustainable development, our economic structure, and of course, climate change. The various combinations of these variables help us to identify what risks may arise, and in turn, anticipate some extreme events. Extreme events create “unpleasant surprises” that can have a deep and lasting impact on how communities grow (Ahn and Skudlark, 2002). Evaluating these events also provides future decision-makers some perspective on the implications of developing response strategies within an environment of rapid change and uncertainty (Lindgren and Bandhold, 2003). Scenario planning can also identify potential opportunities that may arise from the changing times and climate, or even as a product of our decision-making process. Evaluating this chain of decision-making can help us to not only adapt to change, but to assist with creating our desired future (Ogilvy, 2002). Assessing the effects of these forces is an important component of planning for climate change adaptation (UK Climate Impacts Programme, 2000).

Future histories are a way of presenting the scenarios as narratives told from the perspective of an individual writing in the year 2050 and describing events which occurred between 2010 and 2050. The utility of using the future history approach is “...that the story can be imbued with a richness of events, places, people and commentaries...” (Duinker, 2008, p. 6). The future histories of Whitehorse describe how the combined forces of climate change and development may shape the community over the next forty years. Throughout this report, the terms “scenario” and “future history” are used interchangeably.

When we combine projected climate change with the expected growth of the city, it is possible to imagine many futures. No single future presented here is expected to be more likely than another. What is most likely is that the actual future of Whitehorse will be a blend of elements from all future scenarios, including those examples not mentioned in this report. What the future histories do provide us is a framework from which to assess the influence of variability on the complex environmental and socio-economic systems that will shape our future. In the

end, these scenarios help us to assess the likelihood and severity of climate change impacts and provide a basis for measuring risk in the Whitehorse Community Adaptation Plan¹.

This report begins with a brief outline of the methodology used by the project team to develop the community vulnerability scenarios. These scenarios are reported in the format of a narrative future history. The final section of this report documents all adaptations proposed by the community to respond to climate change.

METHODS: CREATING SCENARIOS

At the outset of WhiteCAP, the project team identified two main variables that could drive change in the community over the next four decades: community growth and climate change. The four scenarios of change generated out of these two variables were created using the guidelines set out in *Scenario Planning: The Link Between Future and Strategy* (Lindgren and Bandhold, 2003).

Growth in this case was defined as a change in the community's demographic profile over time and included consideration of population size and age distribution. Other variables associated with growth included the cultural composition of the community, the rate and form of sustainable development, infrastructure development, and the local economy. For the scenarios, we considered growth at the modest and significant ends of the accepted spectrum.

The second independent variable of change represents shifts in the regional climate regime of Whitehorse. The Scenarios Network for Alaska Planning (SNAP) prepared regional projections. Regional projections assessed the potential influence of climate change on annual/seasonal temperature, annual/seasonal precipitation, freeze-up, break-up, and the growing season. Climate projections were based on the B1 and A1B emission scenarios prepared by the Intergovernmental Panel on Climate Change (IPCC) in their Special Report on Emissions Scenarios (SRES). Each projection was evaluated at two time slices (2030 and 2050) in order to create a gradient over which to evaluate how Whitehorse may respond to change over the next four decades. In all, SNAP generated 65 projection maps for consideration during the scenario development process². The B1 and A1B SRES scenarios describe two possible ways that global population and economic development patterns may influence carbon dioxide (CO₂) emissions, in turn influencing the speed and severity of climate change (Nakićenović *et al.*, 2000). B1 scenarios assume an overall reduction in CO₂ by 2050. The A1B scenario assumes the highest level of CO₂ emissions by 2050, peaking in 2060, followed by an overall decline by 2100. The two scenarios were selected to provide the greatest range in the potential onset of climate change in the Whitehorse region by 2050.

The projection scenarios were combined with a local climate trend analysis. The trend analysis considered temperature, precipitation, growing degree days, wind, visibility, runoff, *etc.* Where the trends supported the projections, the climate scenario was presented with more confidence. Where they did not agree, the climate scenario was given a broader range of potential outcomes. As with the growth variable, climate change was then grouped into 'less' and 'more change' bracketed around the mean projections.

1. The *Whitehorse Climate Change Adaptation Plan* (Hennessey and Streicker, in prep) defines a high risk as a consequence of climate change that is severe, likely to occur, and to which the community has a limited capacity to respond.

2. These maps are currently available on the Northern Climate ExChange website (<http://www.taiga.net/nce/adaptation/whitehorse.html#3>) and are presented in full in the *Whitehorse Climate Change Adaptation Plan* (Hennessey and Streicker, in prep).

Four community vulnerability scenarios were generated from the two independent drivers of change identified by the project team through a two-stage process. In the first stage, preliminary vulnerability scenarios were established based on the knowledge and experience of professionals living in the Whitehorse area at a Scenarios Development Meeting held at Yukon College in November 2009. The four scenarios were created based on the ‘scenario cross’ illustrated in Figure 1. Scenarios were defined by low to high growth and low to high climate change. The subject matter of each scenario is described in detail in the following section. The preliminary vulnerability scenarios created at this stage are provided in Appendix A.

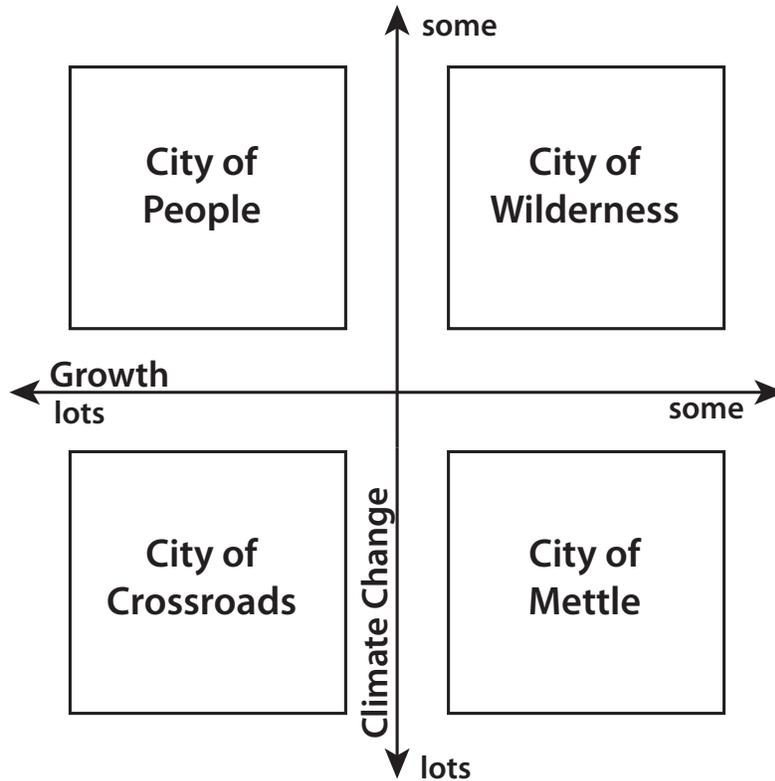


Figure 1. Scenarios Cross for the Whitehorse Future Histories.

In the second stage of the process, the community was invited to a one-day scenario discussion to expand on the preliminary vulnerability scenarios. Fifty participants attended this Whitehorse Community Input Session in January 2010, and added extensive community knowledge. The Technical Advisory Committee (TAC) provided assistance and scientific expertise to WhiteCAP, and met in May 2010 to review the Community Vulnerability Scenarios derived from the Community Input Session. Input from the TAC was integrated into the scenarios, which are presented in full in the following section.

FUTURE HISTORIES OF WHITEHORSE

Four scenarios of community change emerged from the Community Vulnerability Scenario discussions. The scenarios were created through a discussion of how variable demographic growth in the City of Whitehorse and variable changing climate conditions may create specific stresses in the city. Overlap was observed between scenarios, and therefore repetition does

occur. Each scenario is presented below in full. Where repetition does occur, it is an indication that the particular consequence and/or response is independent of the scenario that may occur in our future and therefore is more likely to take place.

Each scenario describes change within the context of some or lots of change (both in growth and climate change), the specifics of which are outlined in each section. Scenario 1 describes the vulnerabilities and opportunities that may emerge from some growth and some climate change. Scenario 2 describes changing conditions associated with rapid growth and some climate change. Scenario 3 envisions some city growth and lots of climate change. Scenario 4, in turn, assesses how significant city growth and lots of climate change may affect the community. Each future history is introduced by an overview of certain characteristics that have evolved in the scenario. The histories are then subdivided into 8 subsections reflecting various sectors and interests in the community: economy, environment, people (culture and lifestyle), infrastructure (buildings, transportation and waste), energy, hazards (fire and flood), food security (agriculture), and health.

CITY OF WILDERNESS: SCENARIO ONE

Some Growth and Some Climate Change

It is 2050. Life in Whitehorse has remained largely unchanged since the turn of the century. Over the past forty years, the City of Whitehorse has experienced slow, but moderate growth. Some 12,000 people have moved into the city since 2010. This increase in the population of the city has placed a strain on our aging infrastructure, but we have had sufficient time to compensate. Driven by our mandate for sustainable development, the City of Whitehorse has invested significantly in renewable and alternative energy sources over the past 40 years. Changing climate conditions have also placed some stress on the community. We have warmed by 2°C over the past 40 years. Winter temperatures have warmed by 3°C and seasonal snowfall has increased by several centimetres.

ECONOMY

The public sector has continued to dominate the Whitehorse economy over the past forty years. The significant proportion of the city's population employed by the public sector has provided some stability to the economy. Overall, economic uncertainty is higher today than it was in the past. This has primarily been due to higher taxation to compensate for an increased cost in snow removal from city streets.

ENVIRONMENT

Whitehorse residents have continued to value and feel a close relationship to the natural spaces in and around the city. Despite this close relationship, development pressures have affected the green spaces, wetlands and watersheds within the city limits. Climate warming has been greater here in the North, compared with the rest of Canada, but it has been at the lower end of our projections. Still, this moderate level of climate change has clearly exacerbated stresses on the environment generated by continued development.

PEOPLE

Whitehorse First Nations continued to experience cultural pressure after 2010 due to the urbanization of the city. A fractured and uncoordinated response from the multiple governments failed to create a cohesive strategy to conserve local traditions and heritage. Today in 2050, the cultural environment of Whitehorse is more complex, increasingly emphasized by a multinational population and a greater connectivity to southern Canada. This has led to the exploitation of an

emerging opportunity, thus leading to partnership agreements that were established between the various governmental organizations in the Territory (federal, territorial, municipal and First Nation). In 2039, many of these partnerships had formally integrated many services, such as infrastructure development and maintenance, and brought people closer together. Adding to the complexity of Whitehorse, the urbanization of the city led to an increase in the standard of living expected by residents, and by 2030 the flexibility of response to climate change had been reduced by the NIMBY (“Not-In-My-Back-Yard”) mindset.

INFRASTRUCTURE

The infrastructure of Whitehorse has continued to age normally. Over the past forty years, infrastructure stress has been due to two factors: the increase in local population and climate change. Changing climate conditions have exerted increasing (although moderate) pressure on infrastructure as the 21st Century progressed. Increased variability and precipitation, especially snowfall, have increased the incidence of traffic accidents and road closures. Increased snowloading on older buildings did cause sporadic damage early in the 2030s, but this problem has largely been addressed over the past few decades. Sufficient institutional capacity was present within the community to address infrastructure issues as they arose, and services have remained unaffected for the most part since 2010. Similarly, sufficient public-sector funding has been made available to replace infrastructure that was nearing the end of its lifespan and/or strained by variable climate conditions.

ENERGY

The continued reliance of Yukon on hydropower through the 21st Century did lead to a limited availability of electricity after 2030. Investment in alternative energy sources for the community, such as wind energy, were explored but largely constrained by our economy of scale. Land-use conflicts also continued to limit the flexibility of the city to capitalize on any alternative energy opportunities emerging from a moderated climate. Warmer winters³ have reduced the heating load. The cost of heating has also been reduced by the increased availability of efficient wood stoves, biofuels, and the increased cost-effectiveness of efficient housing designs/retrofits, which represents the progress of sustainable energy development during this period.

HAZARDS

The combined effect of a longer fire season and variable weather has increased the risk of forest fire in the Whitehorse region. Bowing to development demand, moderate rural residential development has continued on the periphery of the City of Whitehorse and has exacerbated the vulnerability of the community to wildfire. The threat of wildfire has been further compounded by an increased rate of fires started by trees falling on power lines. Limited access and egress points in vulnerable subdivisions have increased the risk associated with forest fires to the community. This vulnerability peaked in 2030, after which the threat of wildfire was reduced somewhat by an increase in the deciduous component of the surrounding forest. Whitehorse has continued to reluctantly embrace FireSmart principles, which remains the dominant fire control mechanism used by the territory. No major fires have affected the region, but wildfire remains a major perceived risk of the community. Due to a lack of funds, evacuation and other egress routes from the city’s subdivisions remains a concern.

Changing winter climate conditions have emphasized regional isolation, and the effect of snow, ice and wind on buildings and power lines remains a concern for residents. The risk of flooding due to spring melt has increased due to rapid melt/break-up. This flood risk is compounded

3. An increase of 1°C could lead to a 5-10% reduction in heating costs (Bob Collins, Energy Solutions Centre, pers. comm., 2010).

by the occasional freezing of the storm drain system as temperatures fluctuate during spring months.

FOOD SECURITY

A moderate increase in growing degree days as a product of climate change has led to a slightly longer growing season in the Whitehorse region. The potential for agriculture and/or greenhouse food production is generally perceived as high. Unfortunately, despite the time and incentive to respond, the City of Whitehorse has hesitated to exploit this potential opportunity due to persistent land-use conflicts such as historic land dispositions and development interests. This lack of development toward food security has been complicated by questions about the balance of land use with water use, the availability of water, and soil suitability. Additional concerns about the introduction of species and diseases from farm animals, has also limited animal husbandry in the region, further limiting local agriculture.

HEALTH

The institutional capacity and funding for health care has been sufficient to compensate for the aging population of Whitehorse. In 2030, some new health risks had emerged within the community. These included ongoing changes with the changing diet of First Nations and the aging population of Whitehorse. Health concerns for First Nations were addressed in part through resources made available to enhance and protect traditional lifestyles. Outdoor recreational opportunities have increased as climate change has moderated local climate conditions. While the rate of recreation-related accidents has increased, the overall health of the community has improved.

CITY OF PEOPLE: SCENARIO TWO

Lots of Development and Some Climate Change

It is 2050. Whitehorse has grown rapidly over the past four decades. Since 2010, the population of the City of Whitehorse has increased significantly and by 2042, 49,690 people inhabited the region⁴. This growth has been due to the new opportunities generated by the changing economic profile of the Territory. The Whitehorse of 2050 has evolved into a small and cosmopolitan city, characterized by a diverse and healthy economy, many cultures, and strong relationships with other Yukon communities.

The close to doubling of the population has also been spurred, in part, by climate change. The moderate climate that emerged across the North over the past 40 years is proving to be very attractive to Canadians. Since 2010, the mean annual temperature of Whitehorse has increased by 2°C, whereby winters warmed more than summers. There was also a mild shift in precipitation, which is now more variable and intense than it was in the 20th century. For example, storms coupled with intense wind are now more common in the region.

ECONOMY

Transfer payments from the federal government have declined as border disputes with other Arctic countries were resolved and the sovereignty agenda of decades past waned. International trade agreements and the resulting increased development across the North have spurred a rapid expansion in the private sector of Whitehorse and the subsequent diversification in the local economy. The spin-off effects of this diversified economy and an increased population have created an improved economy of scale and an increased service sector. The increased service

4. Projected population estimate based on the population reported by the Yukon Bureau of Statistics for December 2009 (YBS, 2010).

sector has led to more jobs in the community and reduced unemployment. The standard of living has been improving across the community as a result.

As business opportunities have evolved, opportunities for the broadening multicultural society of Whitehorse to express itself have emerged and included the opening of more ethnic restaurants, cultural art galleries, *etc.* Economic diversification further underscores the role of the community as a transportation and commercial hub for the Territory, which has led to further economic development within the City of Whitehorse, as well as the outlying communities.

ENVIRONMENT

The increased population and relative growth and escalating sprawl of the City of Whitehorse since 2010 have placed extensive stress on the rivers and lakes in the region. This was reflected by the abrupt change in the tourism profile for the city in 2030. At that time, Whitehorse was no longer advertised as a “wilderness city” but as the “new north”, reflecting the increasingly urban and cosmopolitan feel to the city. Moderate climate change and the booming population, especially in the rural residential neighbourhoods, are having a negative impact on the quality of local water. Specific issues include a continued wasteful use of water by residents and an increase in the temperature of waterways due to climate change. As a result, most riparian systems within the city limits have experienced nitrification leading to losses in fish habitat.

PEOPLE

Development within the city continues along the same trends that were observed before 2010. The housing market remains focused on rural residential development, which has increased the strain on the surrounding environment. Increased multiculturalism has shifted the cultural focus away from First Nations since the 2030s. Today in 2050, the combined forces of rapid development and shifting climate and environmental conditions have marginalized traditional lifestyles in the community. As we enter the second half of this century, First Nation communities have become increasingly more isolated. Many First Nations citizens now advocate an independent community within the city limits.

INFRASTRUCTURE

The infrastructure of Whitehorse has significantly expanded from 2010 to 2050 to accommodate the rapid and dispersed housing boom generated by an almost doubling of the city’s population. The second bridge over the Yukon River facilitated the development in Riverdale and along Long Lake Road. Road and service networks have also significantly expanded to accommodate growth along the Alaska and North Klondike highways in the new rural residential neighbourhoods. The focus on supplementary infrastructure development has left the city’s aging infrastructure in need of renewal. Climate change has exacerbated the strain on infrastructure. For example, highway washouts are now more common, and this puts pressure on the delivery of goods up the highways (*i.e.*, issue of food security). Waste management has also proved increasingly problematic.

ENERGY

Energy security has declined across the region due to our continued dependency on fossil fuels. Not only has oil and gas remained the foundation for Whitehorse’s energy consumption, the demand has increased. Fossil fuels continue to be used wastefully and problems persist with the continued commute of single-occupancy vehicles to the downtown core from rural residential areas, as well as areas outside of the city limits. Although the Alaska pipeline was completed on schedule, a cheap connection to it proved difficult. The hydro potential of the region proved unable to match the demand, and by 2030, this forced the community back to using diesel

generators. No explicit energy strategy has ever been implemented for Whitehorse, although a focus on biofuels has slowly developed to compensate for the rising fuel costs.

HAZARDS

Forest fire risk for Whitehorse has continued to increase over the past four decades. The continued growth in rural residential development has placed more people and buildings in fire zones. The fire risk in these areas has been exacerbated considerably by the variable weather and strong winds generated by changing climate conditions. Climate-induced changes in local forests, such as shifts in composition of the understory and increasingly stressed pine and white spruce populations, also support an increased fire regime. As a result, wildfire has become the dominant climate-related hazard in the region. Despite this, the community has continued to resist the FireSmart program. Subdivisions along the periphery of the city have especially retained a greater risk to hazards. Emergency response in unincorporated communities outside the city limits continues to operate on a volunteer basis, and operate under the jurisdiction of the Territory.

FOOD SECURITY

Years of decreased food security has led to an increasing emphasis on agriculture. By 2030, agriculture had been incorporated into regional land-use planning. Today in 2050, the population of Whitehorse is sufficient to ensure a stable market for local produce. This local market contributes to our economic diversification and ensures that agriculture is now an established part of our industrial landscape. In 2046, the Whitehorse Official Community Plan increased the area zoned for agriculture. Currently, agriculture is limited largely by the increase in agricultural pests which are attributed to a warming climate and the increase in agriculture itself. Pesticides (used to manage invasive species), fertilizers and other pollutants from agriculture may be detracting from the quality of the city's water.

HEALTH

The doubling of the population and increased marketing of Whitehorse as a cosmopolitan centre has attracted a significant demographic of recent retirees. This group of aging population has placed additional strain on local health care provisions; however, it has remained somewhat manageable. Aging infrastructure and warmer water temperatures have led to a decline in water quality and an increase in water-borne diseases in people choosing to drink surface water while engaged in recreation and/or traditional activities on the land.

CITY OF METTLE: SCENARIO THREE

Some Development and Lots of Climate Change

It is 2050. Climate change has been the pressing issue of the 21st century for the City of Whitehorse, outshadowing development as the dominant driver of change in the region. Mean annual temperature has increased 1°C over each of the past four decades. Local precipitation patterns have changed significantly. Winters have become noticeably warmer, and there are frequent incidences of freeze-thaw throughout the season. Snowfall has increased. Summer precipitation tends to be unpredictable, but the regional climate has taken on some coastal characteristics. Overall, the climate tends to be wetter, and skies are commonly overcast for long periods. Over the past 40 years, the population of Whitehorse has increased by 12,000. Development within the city has therefore been moderate, but steady, and predominantly driven by the vision of a sustainable city embraced by the City of Whitehorse in 2009 (City of Whitehorse, 2009). The majority of new development has been focused in the downtown core and much of the area beyond the city limits remains relatively untouched.

ECONOMY

Driven by federal concerns about northern sovereignty, transfer payments to the Territory increased after 2010, as climate change transformed the North. The public sector has continued to dominate the Whitehorse economy for the first half of the 21st century. Economic activity in the region has increased, but financial uncertainty lingers as private-sector growth has remained sporadic and opportunistic. To date, the majority of private-sector growth in Whitehorse has been associated with the shift towards sustainable industry.

ENVIRONMENT

Increased incidences of drought have characterized the period between 2010 and 2050. Regional wetlands and watersheds have been extremely stressed as a result. While the availability of water has declined over the past forty years, the incidence of extreme weather events has increased. Seasonally, the bulk of our summer precipitation now occurs in a few severe storms characterized by heavy precipitation and lightning. The result has been rapid run-off and erosion, which has contributed further to the overall decline of riparian systems in the region. Flooding has increased due to frequent ice-jams in the spring. A rapid spread of drought-tolerant invasive species has proved problematic for endemic species. This spread has proven to be beyond the capacity of volunteer groups and government to control.

PEOPLE

The focused development within the downtown core has encouraged the rise of a highly valued conservation ethic within the community of Whitehorse. This conservation ethic has helped to successfully bridge the gap between First Nations and the rest of community. First Nations traditions have been conserved and emphasized in the community as a result. Addressing climate change has proven to be one of those areas where different levels of government have not been able to coordinate their responses. For example, cross-jurisdictional issues such as biodiversity have been challenging from a jurisdictional perspective.

INFRASTRUCTURE

Modest population growth and the overall drought conditions, which have characterized the past 40 years, have not overly strained infrastructure, as was originally anticipated. Instead, changing climate conditions have fit relatively well into the established tolerances for infrastructure and its renewal schedule. As a result, the City of Whitehorse has invested heavily in new green infrastructure, including geothermal energy, district heating and solar power. Community interest in active transportation has increased since 2010, and the city has developed an extensive commuter and recreational trail system connecting the downtown core to the hinterlands.

ENERGY

The vision of sustainable development embraced by all local governments has led to significant investment in energy conservation and renewable energy generation. Due to the high conservation ethic of the community, changes in the way residents use energy and demand side management have increased local energy security. Investment in wind power took place from 2010 to 2030. An increase in average annual wind speeds has assisted the productivity of this sector, but it is still limited as an intermittent power supply without adequate (renewable) energy storage to back it up.

HAZARDS

Community vulnerability to a catastrophic outbreak of fire has increased due to the concentration of development in the city core. Rural residential development in the hinterlands has remained relatively unchanged since 2010. Outbreaks of severe fires in nearby forests have burned large areas outside the city limits. The increase in the level of flooding has been managed through infrastructure upgrade and development.

FOOD SECURITY

The dry climate of Whitehorse has inhibited the agriculture potential that was anticipated to occur with climate change. Demand for local food has increased as a result of the community's desire for sustainable development. In 2030, a greenhouse development project was undertaken by the City of Whitehorse in partnership with First Nations and territorial governments. South-facing slopes along Grey Mountain Road and along the Alaska Highway were rezoned as agriculture, and private industry was encouraged to develop an aggressive non-soil based food production program through government subsidy. These greenhouses now supply a significant portion of the community's food.

HEALTH

Frequent, severe fires in nearby areas have negatively affected the air quality in the city. Health concerns have subsequently increased. The aging population of the community has also placed some strain on the public health care system. The aging population of Whitehorse has increased due to a significant number of retirees moving into the community from southern locations as a result of the favourable warm, dry climate, as well as the green emphasis in city development.

CITY OF CROSSROADS: SCENARIO FOUR***Lots of Development and Lots of Climate Change***

It is 2050. The combined influence of urban growth and climate change has radically altered the City of Whitehorse over the past four decades. The development of the Alaska Highway Pipeline has sparked a host of similar mega-projects in Yukon. From 2010 to 2030, the population of Whitehorse swelled by 12,000 people, which quickly doubled before leveling off at approximately 50,000 residents by 2040.

The regional climate has also shifted significantly during the same time period. The regional mean annual temperature rose 4°C over the past forty years producing warmer winters and drier summers. Warmer winter conditions have resulted in a 10 cm increase in annual snowfall, and an increase in the snow water equivalent of the region. Despite this net increase in precipitation, drier summer conditions have increased the influence of evapotranspiration resulting in reduced water availability.

ECONOMY

The development of several mega-projects in the Whitehorse area has sparked growth in the community's private sector. This growth has led to an increased role for Whitehorse as an administrative and transportation hub. Unfortunately, a rash of infrastructure and environmental problems has created a number of issues over the past forty years. Many of these problems evolved as a consequence of the rapid growth of the urban population, compounded by rapid climate change. Infrastructure was especially affected and responses were hindered by the constraints of trying to repair infrastructure, while also trying to meet the increasing demands of the growing city. These issues far exceeded the capacity of the community to respond, resulting

in a rapid increase in municipal taxes as the City of Whitehorse struggled to meet the challenges head on. This tax burden has at least been mitigated from the improving economy of scale.

ENVIRONMENT

The combined influences of climate change and rapid growth have strained the wilderness areas around the city. Increases in the average seasonal temperature during winter have created a milder climate; however, these increases have also resulted in an increase in the incidence of freeze-thaw, ice-jams, and an increased rate of flooding. Shifting ice dynamics have scoured local riparian systems increasing erosion and damaging habitat. Summers are now typically characterized by unstable weather and severe storms. Storm runoff has also caused erosion as creeks and streams struggle to cope with the increased levels of water flowing into rivers. Despite the overall increase in precipitation, periods of drought between storms are lengthening. These dry periods have placed extensive pressure on local wildlife, which has been compounded by fragmentation from development and the influx of invasive species favoured by shifting climate conditions.

PEOPLE

A series of climate-related disasters world wide led to a rapid shift in the distribution of ethnic groups across Canada by 2030. At first, the majority of new residents were displaced Canadians, and the French-speaking segment of the population grew especially quickly. However, a diverse range of ethnic groups have now moved north. Whitehorse has become a diverse and multicultural city. The military presence in Whitehorse increased significantly after 2030 as climate change destabilized international boundaries leading to the perception that the northern regions of Canada presented an increased security risk. The rapid rate of change over the past four decades has led to the rise of conflicting lifestyle values, especially where the conservation of the environment is concerned. First Nations culture has become overshadowed. The rapid rate of landscape change has further exacerbated the declining influence of traditional lifestyles in the region.

INFRASTRUCTURE

The City of Whitehorse has struggled to keep pace with the rate of change affecting the region. Significant infrastructure stress has occurred as a result of the combined impact of rapid development and climate change. The expansion of infrastructure has included the construction of a second bridge across the Yukon River and an expansion of the road and utilities network. The capacity of the municipality has been stretched by the costs of rapid growth. The impacts of climate change have included more frequent and severe river flooding, and an increased demand for snow clearing. The cost of responding to these impacts has hindered any coherent infrastructure renewal strategy. Infrastructure development has therefore been largely sporadic and opportunistic as funds and interest have allowed. The City's drive for sustainable development has largely been abandoned as alternative development strategies proved too expensive or time consuming to implement.

ENERGY

Readily available hydro capacity was exceeded by community growth after 2025. Since that time, the community of Whitehorse has relied almost exclusively on oil and gas to meet its energy requirements. While some interest was expressed in exploiting the Alaska pipeline to tap into a cheap and plentiful source of hydrocarbons, the exorbitant cost of infrastructure renewal prevented any real opportunity to implement this solution. The exploration of more sustainable

alternatives was also prevented for similar reasons. The community is currently struggling with ever-increasing energy costs which have further decreased the median income of residents.

HAZARDS

Increased fragmentation of ecosystems, sporadic drought, and a ten-year outbreak of invasive species from 2035 to 2045, has left the forest surrounding Whitehorse highly stressed. The forest now consists of a significant proportion of dead standing wood. Ground fires due to either human negligence or to lightning strikes are now a major risk to the community. Continued rural residential development has left many in the community vulnerable to wildfire. Flood risk has also increased. The heavy precipitation associated with storm events now often exceeds the capacity of the city's storm drainage system, and localized floods occur frequently throughout the city.

FOOD SECURITY

The community of Whitehorse has largely maintained its reliance on outside food sources over the past forty years. As feared in the early years of the 21st century, changing landscape conditions reduced traditional food sources in the community. Competing land-use interests eventually favoured development over agriculture, leading to housing construction on arable land within city limits. Moreover, the installation of extensive irrigation systems to support agriculture due to dry conditions in the region has been prevented by the escalating cost of maintaining infrastructure. The development of irrigation systems was also prevented by concerns over groundwater contamination if aquifers were utilized to support agriculture. Local agriculture has therefore developed in an ad hoc fashion with variable success.

HEALTH

Pressure on the health sector has increased for a number of reasons. First and foremost, many in the community have come to rely on a wide range of substandard and processed foods. Combined with a decline in active lifestyles, poor diet has led to increased obesity, diabetes and other health concerns. As is observed in the rest of the country, the population is now older, creating an increase in the demand for high-quality, extensive health care.

PROPOSED ADAPTATIONS

Participants in the Community Input Session were asked how to adapt to the community vulnerability scenarios they had created. The tables in the following section list the adaptations proposed by participants. These adaptations are based on the sectors used to describe each scenario. Additional adaptations suggested by the Technical Advisory Committee (TAC) which met later in the process have also been listed.

NEXT STEPS

As noted in the introduction, *Future Histories of Whitehorse: Scenarios for Change* documents the scenario planning component of the adaptation planning process for the community of Whitehorse. It represents the first half of the adaptation planning process, describing how community vulnerability to climate change may evolve over the next forty years. As we continue to experience climate change - and all indications suggest that the rate of change will continue and even increase - we will need to plan for it.

But there is a wide range of possible futures in the details and it is best to try and assess which choices present us with few or no regrets as we plan for the future. An estimation of

the likelihood of an event is therefore important to making sound decisions. By evaluating the many paths that the future may take, we can evaluate the likelihood associated with each of the possible impacts of climate change. The common elements identified through the development of the future histories of Whitehorse are indicative of the consequences that are likely to occur.

These common elements include an increased risk of forest fire, which was a component of even the most moderate of the four scenarios. Shifts in the availability of water were also common to all scenarios, characterized by either an increase or decrease in the local water budget. This shift in water availability was increasingly evident in the more severe scenarios where the threat of ice jamming and flooding increased, as did the potential for regional drought. Infrastructure decline occurred in every scenario with the exception of Scenario 3, indicating that climate change will likely be an ongoing concern with respect to infrastructure renewal. The exception noted in Scenario 3 was largely due to the focus on sustainable development, which could only occur under the very specific circumstances described in that narrative. Energy security was also problematic in every scenario but 3, the exception occurring for the same reason as that of infrastructure. There is also an evident need to address the potential for land-use conflicts at the periphery of the city to accommodate the various interests currently established there.

In the second half of the adaptation planning process we will assess the risk associated with emerging vulnerabilities described in this report. This risk assessment will form the basis of the recommendations made in the *Whitehorse Climate Change Adaptation Plan* (Hennessey and Streicker, in prep). In that report, we will evaluate the proposed adaptations to see how they respond to the range of change suggested by the scenarios. Based on the findings of this report, adaptations that respond to forest fire, aging community infrastructure, land-use conflicts, and water quality/availability are most likely to be of priority. Adaptations will almost certainly require building community capacity in order to ensure that adequate responses to the host of issues explored here are feasible. By addressing a range of possible vulnerabilities, the adaptations recommended by the plan will create a robust strategy for the community of Whitehorse to prepare for climate change.

Table 1. Proposed general adaptations as determined by the community and the Technical Advisory Committee (TAC).

Scenario	Adaptations
Scenario 1	<ul style="list-style-type: none"> • must consider mitigation to ensure we can be resilient • need to prioritize based on our capacity and risk
Scenario 2	<ul style="list-style-type: none"> • need to work together, not in silos and with a discussed level of partnership
Scenario 3	<ul style="list-style-type: none"> • gather and collect local observations from both a traditional and scientific perspective • more funding must be allocated to monitoring fish, wildlife and the environment • funds for monitoring must flow to Territorial and First Nations governments • fund local monitoring programs, including the training of citizen scientists • take advantage of electronic technologies to gather, store and share information
Scenario 4	<ul style="list-style-type: none"> • adaptation should include mitigation • integrate things we do need, <i>e.g.</i>, reduce fuel load through FireSmart, organic waste disposal, liquid gasifier to produce power and heat, and charcoal used in agriculture soil • adaptation should also mitigate and/or address critical issues such as social issues, fuel costs, increased capacity, <i>etc.</i> • narrow the gap between elite and ‘other’ in the community to increase overall social well-being and make sure everyone has access to the same resources • look at risks in the landscape and mitigate development in those areas • incorporate social justice in all decision-making processes to create a more resilient community • look further than a population of 50,000 – what happens after that? • partner with all levels of government to share burden, and ensure downloading of responsibility comes with capacity
TAC	<ul style="list-style-type: none"> • adapt to those impacts we can identify now, but continue to build on improving our knowledge and understanding so that we may anticipate future impacts • consider full life-cycle (cradle to cradle) of adaptations and integrate solutions to address multiple impacts

Table 2. Proposed economic adaptations as determined by the community and the Technical Advisory Committee (TAC).

Scenario	Adaptations
Scenario 1	<ul style="list-style-type: none"> • adapt to those impacts we can identify now, but continue to build on improving our knowledge and understanding so that we may anticipate future impacts (economic and otherwise)
Scenario 2	<ul style="list-style-type: none"> • focus on opportunities • be aware of downsides and compensate accordingly • focus on economic development to support needed programs – establish education to support economic diversification • support opportunities for local manufacturing/mix-use development • encourage local restaurants to buy local produce • market Yukon goods
Scenario 3	<ul style="list-style-type: none"> • reduce poverty and decrease inequality to build resilience to climate change • increase student grants • make post-secondary education accessible to all • guarantee annual income
Scenario 4	<ul style="list-style-type: none"> • increase the need for Whitehorse to serve as a hub, which will have a trickle-down effect, <i>e.g.</i>, dollars coming from outside will benefit the communities (<i>i.e.</i>, if Whitehorse cannot supply, then others are vulnerable)
TAC	<ul style="list-style-type: none"> • promote a more diversified economy (<i>i.e.</i>, move away from boom-bust) • build economic resilience to climate change

Table 3. Proposed environmental adaptations as determined by the community and the Technical Advisory Committee (TAC).

Scenario	Adaptations
Scenario 1	<ul style="list-style-type: none"> • need to maintain corridors around critical habitat areas • give substance to greenspaces plan (build resilience to climate change) • need to re-assess situations and values over time while planning for change now • evapotranspiration and groundwater recharge are critical and uncertain, therefore we need to retain capacity and expertise in these areas • need for a holistic/life-cycle management (<i>e.g.</i>, water life cycle includes how it passes through the human-built world)
Scenario 2	<ul style="list-style-type: none"> • create and implement a groundwater management plan • water metering • monitor water quality and quantity, fish, wildlife and other environmental indicators • increase our use of grey water for other purposes (toilets, plants) • create an education program around water conservation • continue to emphasize water conservation principles – avoid shipping water out of the Territory • look into a strategy to enforce the protection of riparian buffers • make any sale of water taxable so the community benefits
Scenario 3	<ul style="list-style-type: none"> • gather and collect local observations/data conclusions from both scientific and traditional perspectives • monitor changes • restore weather stations • set aside funding to monitor fish, wildlife and the environment • funds must flow to the Territorial and First Nations governments • train (and pay) local people for monitoring • take advantage of digital technologies to gather, store and share information; this information database must consider the abilities of the users in terms of accessibility
Scenario 4	<ul style="list-style-type: none"> • increase research and monitoring • look into other areas with similar biophysical characteristics to predict what changes may occur and how to address them • look at local solutions and the subsequent impacts on wildlife movement (<i>e.g.</i>, Little Salmon Carmacks FN clears snow paths for animals as an adaptation to increases in the local snow load along corridors)
TAC	<ul style="list-style-type: none"> • develop groundwater management plan • aquifer monitoring

Table 4. Proposed cultural and lifestyle adaptations (for people) as determined by the community and the Technical Advisory Committee (TAC).

Scenario	Adaptations
Scenario 1	<ul style="list-style-type: none"> • seek value-driven responses, but recognize that we have always emphasized diverse value sets, independence and tolerance • acknowledge that Whitehorse provides services to other Yukon communities
Scenario 2	<ul style="list-style-type: none"> • focus on opportunities to learn from other communities to the south (outside of the Territory) in order to respond proactively to population growth challenges • enjoy the benefits of a larger and diverse population – benefit from an increase of available skill-sets, which could be supported by programs and policy development
Scenario 3	<ul style="list-style-type: none"> • create more partnerships • integrate government services
Scenario 4	<ul style="list-style-type: none"> • potentially cap population growth to ensure a healthy environment for residents • come up with a vision and ensure new development adheres to that vision
TAC	<ul style="list-style-type: none"> • develop constructive partnerships

Table 5. Proposed infrastructure adaptations as determined by the community and the Technical Advisory Committee (TAC).

Scenario	Adaptations
Scenario 1	<ul style="list-style-type: none"> • establish a budget for dealing with climate-change impacts (e.g., roads and road clearing) • use multiyear funding to accommodate climate variability (e.g., roads and road clearing) • recommend community densification allowing for greater cost sharing of infrastructure • educate the public to understand the nature of climate change impacts and adaptations in order to set a fair expectation for quality of service, i.e., lifestyles may have to change • reduce downtown vehicle traffic and pressure on roads through densification, mixed-use zoning and improved transit • need to identify critical thresholds, responsibilities and partnerships
Scenario 2	<ul style="list-style-type: none"> • re-open the railway corridor and repair the old rail link into the downtown • monitor the viability of public transportation as population increases, i.e., public transit will work better with a larger population • promote active living and active living solutions • look into the feasibility of a commuter train • investigate strategies that link the traffic network, i.e., facilitate vehicle traffic and public transportation • install communication infrastructure to facilitate people working from home • link service centres to transit hubs to encourage public transit • link public transit to active transportation • do net-metering • look into feasibility of micro-hydro • revisit Skagway as a transportation node • increase available warehousing (i.e., links to food storage) • expand active road monitoring stations in problem areas (roads and intersections) • explore feasibility of automatic de-icing at problem road intersections • set aside snow storage areas in new subdivisions • learn from other circumpolar countries • reduce input or expand treatment sewage lagoon in the near future • source-separation of untreatable garbage in order to reduce leaching • increase storm water retention within the city; allow for on site-disposal, e.g., create porous parking lots • tax packaging (e.g., plastic and plastic bags) to promote responsible packaging, i.e., create a cost for using packaging • create a hazardous materials transfer station • support recycling as a growth industry
Scenario 3	<ul style="list-style-type: none"> • assess dependence of Whitehorse to highway, and vulnerability of highway outside of city limits to climate change

Table 5. Proposed infrastructure adaptations, *continued*.

Scenario	Adaptations
Scenario 4	<ul style="list-style-type: none"> • need to address site drainage issues in order to avoid mould problems, <i>i.e.</i>, requires better inspections and enforcement of codes • repave roads with permeable pavement, or an alternative that is appropriate for a northern climate • assess storm drainage capacity/capability and design for extremes in future climate projections when being replaced through maintenance schedules • ensure sewage and storm-water systems are separate in case of flooding • storm system discharge needs to be treated if road treatments and/or pollution is present • ensure standards and regulations are ‘living’ so they are changed as we improve our knowledge base • manage local green spaces for ecological/socio-economic purposes • have flexible zoning (beyond the downtown core) to allow for densification increases in other areas of the city in order to avoid rural residential development • design neighbourhoods outside the downtown core that will have services • build a second bridge to Riverdale • all regional and other relevant planning needs to be revisited regularly • redesign buildings if there are problems down the road, <i>e.g.</i>, retrofitting insulation • diversify energy sources to ensure people have what is needed in various situations • use buildings as carbon sinks and/or use waste materials for insulation • incorporate waste/local materials in building design/construction to create more affordable housing • develop better air ventilation in buildings in order to reduce mould if precipitation increases • build new infrastructure with R-60 values • need local policy to ensure housing issue is addressed, <i>e.g.</i>, code for insulation at the local policy level • energy efficiency testing needs to be implemented • generate standards/best practices for subdivision development that addresses climate change, energy, forest fire, wind breaks, <i>etc.</i> • promote education and training to compensate for increased snow loads • look at technologies that can help us prepare for changes down the road and implement them now • incorporate storage tanks into all new structures • improve capacity limitations • create a strategy to move forward as demand for waste management constrains flexibility • create a strategy to compensate for capacity issues as people and expertise are strained by changing climate conditions • create a strategy to capitalize on the potential increased need for Whitehorse to serve as a hub, <i>i.e.</i>, incorporate the trickle-down effect to communities (if Whitehorse cannot supply, then others are vulnerable)
TAC	<ul style="list-style-type: none"> • increase research and monitoring of infrastructure in order to identify critical thresholds, cost benefit, responsibilities and partnerships • communicate with partners and government departments with regard to concerns and opportunities identified within this exercise to inform their respective planning processes

Table 6. Proposed energy security adaptations as determined by the community and the Technical Advisory Committee (TAC).

Scenario	Adaptations
Scenario 1	<ul style="list-style-type: none"> • create an energy plan for Whitehorse (including comprehensive energy management) • increase self-sufficiency and local resilience through mitigation of climate change (integrate with update of LAP* – CGC** is a big consumer) • establish a priority for local solutions that ensure the city’s energy supply • respond to the need for energy storage (even in homes) • create a response to energy load issues, <i>e.g.</i>, diversify in order to evenly distribute the load demands • explore groundwater as a low-energy geothermal opportunity • promote seasonal energy uses, <i>e.g.</i>, greenhouses • use biofuels*** (possibly as district heating) thus reducing Firesmart and salvage wood harvest aversions • promote and implement energy solutions
Scenario 2	<ul style="list-style-type: none"> • examine increased wind power – need to be careful of subsequent impacts • continue to investigate the feasibility of district heating • install solar power systems and explore the feasibility of solar energy • explore the off-gassing from landfill to generate heat or electricity • explore the feasibility of gasification • investigate geotechnical constraints to power generation
Scenario 3	<ul style="list-style-type: none"> • examine the feasibility of any benefits associated with the gas pipeline
Scenario 4	<ul style="list-style-type: none"> • support net metering**** and independent power production • ensure local energy self-sufficiency by connecting the grid to Mayo • look at a regional plan to increase local access to energy sources outside the City of Whitehorse
TAC	<ul style="list-style-type: none"> • promote super-green construction to reduce heat demands • take advantage of benefits if gas pipeline comes (will not be cost effective at our current economy of scale)

* LAP = Local Action Plan

** CGC = Canada Games Centre

*** A fuel type derived from biomass, such as wood or grass.

**** Net metering allows electricity customers to sell surplus electricity produced from small-scale, renewable energy sources back to the grid. Net metering customers receive a credit for the electricity they generate.

Table 7. Proposed adaptations to potential hazards (fire and flood) as determined by the community and the Technical Advisory Committee (TAC).

Scenario	Adaptations
Scenario 1	<ul style="list-style-type: none"> • incorporate fire considerations in all subdivision planning and zoning (such as no dead ends, provision of fire breaks, aspen plantings, access to water, plus other holistic planning) • increase densification of city, <i>i.e.</i>, substantiate densification option • pass consequences of climate change on to other decision-making groups involved in planning, design, engineering and establishing standards for subdivision development, road construction and infrastructure • incorporate climate change and potential hazards into infrastructure development currently in the planning stages • attempt to manage the landscape to remediate against slope failure (<i>e.g.</i>, avoid danger areas through zoning) • reduce water on the clay cliffs • integrate climate-change risk and impact into emergency planning • consider treatments for contaminants in runoff, such as from airport de-icing
Scenario 2	<ul style="list-style-type: none"> • allow fire department greater latitude for proactive responses • consider fuel abatement and fuel mitigation (produces biomass) • install a system of air monitoring and issue quality warnings • establish a proactive program for residents that reduces fire threats around homes (already required) • develop a second strategy for community-based disaster response, <i>i.e.</i>, equates to a residential fire strategy • enhance building codes: consider biomass heating to maintain air quality and reduce the risk of structural fire • continue education with regards to responsible fire safety • create a strategy for harvesting salvage wood (<i>e.g.</i>, from construction and insect damage) as both an opportunity and a control measure • ensure fire safety is incorporated into residential planning (<i>e.g.</i>, densification can be buffered better than rural residential development) • FireSmart vulnerable infrastructure
Scenario 3	<ul style="list-style-type: none"> • create zoning that reflects potential future changes in the landscape
Scenario 4	<ul style="list-style-type: none"> • promote climate-change education and training for safety sector • ensure critical buildings have back-up power for lighting/heating in case of emergencies • FireSmart around areas of development • maintain green spaces and/or strategic agriculture to reduce fire risk
TAC	<ul style="list-style-type: none"> • investigate and assess risk of catastrophic flood scenarios • encourage/support redundant emergency systems on both sides of the river (to prepare against potential loss of bridge to Riverdale)

Table 8. Proposed food security adaptations as determined by the community and the Technical Advisory Committee (TAC).

Scenario	Adaptations
Scenario 1	<ul style="list-style-type: none"> • chose crops that conserve water or are not water intensive • use agriculture to build soil • possibly limit land dispositions to small plots, highlighting need for tighter controls • explore urban gardening and community greenhouse opportunities • allow local livestock (e.g., chickens) to be raised for self-sufficiency • continue to expand on education opportunities for regional agriculture
Scenario 2	<ul style="list-style-type: none"> • encourage small community plots • investigate improving efficiency of food transportation • encourage more community gardens and personal gardens (i.e., convert lawns to gardens) • place a moratorium on subdividing agriculture land • investigate new and innovative ways to grow food • increase animal husbandry in the region • create co-op gardens • create food security plans that address poverty issues by the sharing of food • increase the number of fish farms • provide a support network for community gardens so food can be sold • build processing facilities and cold storage • circulate waste heat and carbon dioxide from accessible sources for local greenhouses • develop more conservation measures to protect traditional foods including the sharing of traditional foods and the identification of suitable/viable alternatives for traditional foods that are no longer available • make a portable abattoir available in Whitehorse • create policies to encourage the use of greywater for agriculture purposes • create and implement a Whitehorse/Territory-wide food security plan • evaluate and monitor invasive species that could affect agriculture • protect river corridors through land-use planning to ensure the conservation of important habitat
Scenario 3	<ul style="list-style-type: none"> • create an education campaign for sustainable food consumption • encourage small-scale gardens and provide training for gardeners • zone more agriculture land • encourage a shift in eating habits to consume locally and seasonally • develop workshops on hunting and gathering (economically) so that traditional skills are more widespread • investigate better ways to import food into Yukon • encourage employers and schools to allow time off to harvest crops and wildlife • share knowledge of food growth between First Nations and western science
Scenario 4	<ul style="list-style-type: none"> • increase the availability of stored goods • educate about local household gardening/canning/drying • balance hunting regulations to ensure the viability of traditional foods • use strategic agriculture areas to act as a food break
TAC	<ul style="list-style-type: none"> • recognize opportunity to extend market season • build processing facilities and cold storage • increase irrigation infrastructure in region

Table 9. Proposed health sector adaptations as determined by the community and the Technical Advisory Committee (TAC).

Scenario	Adaptations
Scenario 1	<ul style="list-style-type: none"> • identify all health risks associated with climate change • promote an outdoor lifestyle
Scenario 2	<ul style="list-style-type: none"> • do more health research • encourage individuals to take responsibility for their health (e.g., eat right, don't smoke, etc.) • develop a strategy to break the pattern of 80% of hospital visits by 20% of the population • market Whitehorse as a 'healthy community' • increase emphasis on active living • educate more health practitioners in Yukon • maintain and expand our green spaces • ensure we have adequate and healthy foods
Scenario 3	<ul style="list-style-type: none"> • subsidize the Canada Games Centre so it is free for those who cannot afford it • Canada Games Centre must remain functional and viable, i.e., needs regular Government of Yukon funding • tax junk/processed food and use revenues to subsidize local healthy foods based on the GST model • make the junk food tax visible • integrate gardening into the school curriculum (similar to the hunting curriculum)
Scenario 4	<ul style="list-style-type: none"> • expand the hospital to locate emergency services on the other side of the river (in case of bridge failure)
TAC	<ul style="list-style-type: none"> • promote personal responsibility for healthy lifestyle as well as the potential for an increase in recreational/outdoor lifestyle opportunities offered by a warmer climate • promote local/healthy foods

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APPENDIX A - PRELIMINARY VULNERABILITY SCENARIOS

Scenario 1



Northern Climate Exchange WhiteCAP Project

independent information, shared understanding, action on climate change

WhiteCAP Scenarios Intro

Whitehorse is projected to change in the coming decades, not only with a warming climate, but also as a result of growth and development. To understand how to respond to the changing climate we will experience in the coming years, we have developed several possible stories of the future. On November 9, 2009, specialists met at Yukon College to brainstorm on these scenarios. The group included experts on climate, economy, infrastructure and planning. The goal was to brainstorm elements of four vulnerability scenarios which will act as a framework for our adaptation planning.

There is always uncertainty with both climate change projections and the expected changes to the community of Whitehorse (population, economic growth, etc.). One of the ways to address this uncertainty is to develop a range of plausible scenarios, which bracket the most likely outcomes. While we won't know which scenario or even which components within a scenario will become our future, we have reasonably high confidence our future Whitehorse will largely fall within this range of possibilities.

Your scenario is described below as a narrative with additional details on the back page for your information. Your group will be discussing how we should prepare for and respond to climate change consequences in this future Whitehorse. Try to imagine where the community is vulnerable and where it is resilient, how we can avoid or reduce the risks of climate change and how we can take advantage of opportunities which arise.

Scenario 1 - Some Growth and Some Climate Change



This story is a Whitehorse which experiences some growth and climate change over the next 40 years. The change is at the modest end of our projections: slow and steady yet still significant.

After several years without much growth, Whitehorse will grow by 6000 people by 2030 and double that by 2050. The economy will grow with the public sector continuing to dominate.

Whitehorse is expected to warm by about 1°C in the next 20 years, and 2°C by 2050, with winters changing more than summers. The climate will be windier, with more intense precipitation and be more variable than it has been.

Infrastructure strain will continue to increase, but the institutional capacity of the public sector will be sufficient to compensate for the changes. Despite this increased strain on infrastructure the trend toward sustainability will increase.



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APPENDIX A - PRELIMINARY VULNERABILITY SCENARIOS

Scenario 1, *continued.*



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Scenario 1	Some Growth and Some Climate Change
Population	<ul style="list-style-type: none"> • After several years without much growth, the City experiences an influx of 6000 people by 2030, and double that by 2050
Economy	<ul style="list-style-type: none"> • Public sector continues to dominate • More opportunity for proactive solutions • Piecemeal growth reflecting current development trends
Climate	<ul style="list-style-type: none"> • Whitehorse is expected to warm by about 1°C in the next 20 years, and 2°C by 2050 • Winters will see more change with warming and snow (projected to increase several cm)
Environment	<ul style="list-style-type: none"> • More wind (intensity and frequency) • More variable weather and intense rainfall • Groundwater flooding • Later freeze-up and earlier break-up • More periods of mid-winter melt • Some pressure on plants and animals due to climate change and invasive species
People	<ul style="list-style-type: none"> • Lifestyle remains consistent; recreation remains an important part of community values • Opportunities and resources are available to protect and enhance First Nations traditional lifestyle
Sustainability	<ul style="list-style-type: none"> • Moderate strain on built infrastructure • Lag time is sufficient for renewal & sustainable alternatives
Infrastructure	<ul style="list-style-type: none"> • Public sector funding available for infrastructure • Infrastructure ages normally • Institutional capacity is sufficient to compensate for changes
Energy	<ul style="list-style-type: none"> • Increase in wind power (more wind and opportunity for proactive solutions) • Moderate to high sustainable development
Fire	<ul style="list-style-type: none"> • Variable weather leading to times when the forest is dry • Longer fire season • More deciduous forest mix • Moderate rural residential development • Some increased vulnerability to fire
Agriculture	<ul style="list-style-type: none"> • Moderate increase in growing degree days • Longer growing season • Time to respond • Incentive to take advantage of opportunities • Potential for agriculture and/or greenhouse production is high



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APPENDIX A - PRELIMINARY VULNERABILITY SCENARIOS

Scenario 2



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WhiteCAP Scenarios Intro

Whitehorse is projected to change in the coming decades, not only with a warming climate, but also as a result of growth and development. To understand how to respond to the changing climate we will experience in the coming years, we have developed several possible stories of the future. On November 9, 2009, specialists met at Yukon College to brainstorm on these scenarios. The group included experts on climate, economy, infrastructure and planning. The goal was to brainstorm elements of four vulnerability scenarios which will act as a framework for our adaptation planning.

There is always uncertainty with both climate change projections and the expected changes to the community of Whitehorse (population, economic growth, etc.). One of the ways to address this uncertainty is to develop a range of plausible scenarios, which bracket the most likely outcomes. While we won't know which scenario or even which components within a scenario will become our future, we have reasonably high confidence our future Whitehorse will largely fall within this range of possibilities.

Your scenario is described below as a narrative with additional details on the back page for your information. Your group will be discussing how we should prepare for and respond to climate change consequences in this future Whitehorse. Try to imagine where the community is vulnerable and where it is resilient, how we can avoid or reduce the risks of climate change and how we can take advantage of opportunities which arise.

Scenario 2 - Lots of Growth; Some Climate Change



This story is a Whitehorse which grows, in particular outside of government in the resource sector. At the same time, it experiences only modest climate change. In this scenario transfer payments from the federal government level off and possibly even decline as we gain in self-sufficiency.

Whitehorse is now projecting significant boom. It will be up 12000 people by 2030 and double our current population by 2050!

Whitehorse is expected to warm by about 1°C in the next 20 years, and 2°C by 2050, with winters changing more than summers. We expect later freeze-up and earlier break-up.

An increasing percentage of the population will be employed by the resource, service, commercial & industrial sectors. Whitehorse will continue and increase as the hub for other Yukon communities. There will be infrastructure development, e.g. the Alaska Highway pipeline and a 2nd bridge built crossing the Yukon river. Part of this development will include locally driven sustainability efforts, e.g. biofuels.



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APPENDIX A - PRELIMINARY VULNERABILITY SCENARIOS

Scenario 2, *continued.*



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Scenario 2	Lots of Growth; Some Climate Change
Population	<ul style="list-style-type: none"> • After several years without much growth, the City is now projecting significant growth, up 12000 people by 2030 and double our current population by 2050 (50000) • Growth in all areas of the city consistent with current trends
Economy	<ul style="list-style-type: none"> • Transfer payments from the federal government level off and possibly decline • Increased % of population employed by resource, service, commercial & industrial sectors and decrease in % of population in the government sector • Cost of living rises modestly • Whitehorse becomes even more of a hub for communities
Climate	<ul style="list-style-type: none"> • Whitehorse is expected to warm by about 1°C in the next 20 years, and 2°C by 2050 • Winters will see more change with warming and snow (projected to increase several cm)
Environment	<ul style="list-style-type: none"> • More wind (intensity and frequency) • More variable weather and intense rainfall • Groundwater flooding • Later freeze-up and earlier break-up • More periods of mid-winter melt • Biodiversity change
People	<ul style="list-style-type: none"> • Greater population embraces country residential lifestyle resulting in environmental pressure on the hinterlands of Whitehorse • First Nations culture becomes vulnerable to rapid development and increased multiculturalism
Sustainability	<ul style="list-style-type: none"> • Moderate sustainable development
Infrastructure	<ul style="list-style-type: none"> • 2nd bridge built crossing Yukon River • Increase in development • Flooding from snow melt and spring freshet • Increased strain on infrastructure by population • More frequent damage to infrastructure by trees uprooted by wind
Energy	<ul style="list-style-type: none"> • Rising oil and gas costs and continued dependency on fossil fuels • Alaska highway gas pipeline built • Focus on biofuels to compensate for rising fuel costs
Fire	<ul style="list-style-type: none"> • More wind and variable weather • Biodiversity change supports increased fire regime • Growth in rural residential development places more people and buildings in fire zones • Forest fire risk is increased
Agriculture	<ul style="list-style-type: none"> • Moderate increase in growing degree days • More predictable rainfall with longer growing season • Time to respond • Demand for local agriculture is high, and available workforce • Focus on agriculture



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APPENDIX A - PRELIMINARY VULNERABILITY SCENARIOS

Scenario 3



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WhiteCAP Scenarios Intro

Whitehorse is projected to change in the coming decades, not only with a warming climate, but also as a result of growth and development. To understand how to respond to the changing climate we will experience in the coming years, we have developed several possible stories of the future. On November 9, 2009, specialists met at Yukon College to brainstorm on these scenarios. The group included experts on climate, economy, infrastructure and planning. The goal was to brainstorm elements of four vulnerability scenarios which will act as a framework for our adaptation planning.

There is always uncertainty with both climate change projections and the expected changes to the community of Whitehorse (population, economic growth, etc.). One of the ways to address this uncertainty is to develop a range of plausible scenarios, which bracket the most likely outcomes. While we won't know which scenario or even which components within a scenario will become our future, we have reasonably high confidence our future Whitehorse will largely fall within this range of possibilities.

Your scenario is described below as a narrative with additional details on the back page for your information. Your group will be discussing how we should prepare for and respond to climate change consequences in this future Whitehorse. Try to imagine where the community is vulnerable and where it is resilient, how we can avoid or reduce the risks of climate change and how we can take advantage of opportunities which arise.

Scenario 3 - Lots of Climate Change; Some City Growth



This story is a Whitehorse which experiences lots of climate change and only modest growth, however, there is a strong move towards sustainability through public interest and the availability of public funds.

In this scenario, Whitehorse population grows by 6000 people by 2030 and 12000 people by 2050. The percentage of people employed in the government workforce remains high.

Whitehorse warms by 2°C over the next 20 years and 4°C into 2050. Winters see more change with warming and an increase in annual snowfall and precipitation. The climate will be more extreme with more freeze-thaw cycles being experienced.

There will be some strain on infrastructure due to population growth, but more infrastructure strain will result from climate change (e.g. snow clearing). Development of both conservation and renewable technology is high. Fire risk is significantly increased.



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APPENDIX A - PRELIMINARY VULNERABILITY SCENARIOS

Scenario 3, *continued.*



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Scenario 3	Lots of Climate Change; Some City Growth
Population	<ul style="list-style-type: none"> • After several years without much growth, the City is now projecting an increase of 6000 people by 2030, and double that by 2050 • Growth develops dominantly in the core (downtown) • Higher turnover of population by 2050
Economy	<ul style="list-style-type: none"> • Public sector continues to dominate • Climate change drives northern sovereignty issues • Economy of scale is not present but transfer payments compensate
Climate	<ul style="list-style-type: none"> • Whitehorse is expected to warm by about 2°C in the next 20 years, double that by 2050 • Winters will see more change with warming and an increase in snow (10 cm)
Environment	<ul style="list-style-type: none"> • More wind by 2030 and leveling off by 2050 • More extreme weather and lightning • Periods of drought • Going through freeze-thaw more often, creating more frequent ice-jams • Run-off and increased erosion • Stressed species
People	<ul style="list-style-type: none"> • Transfer payments increase • Lifestyle shifts in response to climate change, emphasizing sustainable choices • Active transportation increases, resulting in a greater number of trails in the hinterlands and in the downtown core • First Nations culture is conserved and emphasized in community
Sustainability	<ul style="list-style-type: none"> • Hinterland reserved for recreation • Sustainable solutions focus on core areas • Demand side management is high because of climate change • Behaviour modification and conservation values are high • High sustainable development
Infrastructure	<ul style="list-style-type: none"> • Climate pressure on infrastructure increases (e.g. highways, roads, wastewater treatment...) • Infrastructure demand for snow clearing • Increased development of geothermal energy, district heating, etc. in downtown core
Energy	<ul style="list-style-type: none"> • Focus on energy conservation and renewables leading to sustainable development
Fire	<ul style="list-style-type: none"> • Trees stressed • More lightening • Reduced hinterland development • Rural residential development remains at 2010 levels • Fire vulnerability is moderately increased
Agriculture	<ul style="list-style-type: none"> • Significantly increased growing degree days • Unpredictable rain and less sunlight • Need to control pests due to shift from semi-arid to wetter climate • Potential for agriculture is low, while demand is high - reliance on greenhouses



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APPENDIX A - PRELIMINARY VULNERABILITY SCENARIOS

Scenario 4



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WhiteCAP Scenarios Intro

Whitehorse is projected to change in the coming decades, not only with a warming climate, but also as a result of growth and development. To understand how to respond to the changing climate we will experience in the coming years, we have developed several possible stories of the future. On November 9, 2009, specialists met at Yukon College to brainstorm on these scenarios. The group included experts on climate, economy, infrastructure and planning. The goal was to brainstorm elements of four vulnerability scenarios which will act as a framework for our adaptation planning.

There is always uncertainty with both climate change projections and the expected changes to the community of Whitehorse (population, economic growth, etc.). One of the ways to address this uncertainty is to develop a range of plausible scenarios, which bracket the most likely outcomes. While we won't know which scenario or even which components within a scenario will become our future, we have reasonably high confidence our future Whitehorse will largely fall within this range of possibilities.

Your scenario is described below as a narrative with additional details on the back page for your information. Your group will be discussing how we should prepare for and respond to climate change consequences in this future Whitehorse. Try to imagine where the community is vulnerable and where it is resilient, how we can avoid or reduce the risks of climate change and how we can take advantage of opportunities which arise.

Scenario 4 - Lots of Climate Change; Lots of Growth



This story is a Whitehorse which experiences lots of change both in growth and in climate. We call it *Bright Lights - Big City*. All this change leads to an ongoing tension between development and environment.

Whitehorse growth booms, up 12000 people by 2030 and double our current population by 2050! This growth is fueled by a mega-project (e.g. the Alaska Highway Gas Pipeline).

At the same time, Whitehorse warms 2°C by 2030, double that by 2050. Climate change drives northern sovereignty issues and even higher federal government transfer payments ensue.

The climate is more extreme including more intense precipitation and periods of drought. Run-off, increased erosion and increased groundwater flooding are projected. Pressure on infrastructure is high. Rapid change outstrips our increase in sustainable development; the net effect is that sustainability is low.



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APPENDIX A - PRELIMINARY VULNERABILITY SCENARIOS

Scenario 4, *continued.*



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Scenario 4	Lots of Climate Change; Lots of Growth (Bright Lights - Big City)
Population	<ul style="list-style-type: none"> • After several years without much growth, the City is now projecting significant growth, up 12000 people by 2030 and double our current population by 2050 (50000) • Forced densification across the city, especially in the downtown core
Economy	<ul style="list-style-type: none"> • Private sector grows faster than public sector (median income declines) • Cost of living increases • Problems outstrip benefits of improved economy of scale • Whitehorse becomes even more of a hub
Climate	<ul style="list-style-type: none"> • Whitehorse is expected to warm by about 2°C in the next 20 years, double that by 2050 • Winters will see more change with warming and an increase in snow (10 cm) • Despite net increase in precipitation, increase in evaporation means a drier climate
Environment	<ul style="list-style-type: none"> • More wind by 2030 and leveling off by 2050 • More extreme weather and lightning • Periods of drought increase • Going through freeze-thaw more often • More frequent ice-jams • Run-off and increased erosion • Pressure on plants and animals due to climate change and invasive species
People	<ul style="list-style-type: none"> • Conflicting lifestyle values compete as a result of rapid change (e.g. development vs. conservation) • First Nations culture is threatened by population stresses and changing landscape conditions.
Sustainability	<ul style="list-style-type: none"> • Development vs. environment tension remains • Low sustainable development
Infrastructure	<ul style="list-style-type: none"> • 2nd bridge built crossing Yukon River • More frequent and severe river flooding • Increased demand for snow clearing • Increased strain on infrastructure by population and climate change
Energy	<ul style="list-style-type: none"> • Pipeline or other mega-project • May increase access to fossil fuels
Fire	<ul style="list-style-type: none"> • Trees stressed • More lightning • More vulnerable population (rural residential) • Forest fire vulnerability is significantly increased
Agriculture	<ul style="list-style-type: none"> • Significant increase in growing degree days • Unpredictable rainfall; overall climate is more arid • More pests • Broad development • Economy is focused elsewhere • Agriculture develops on an ad hoc basis with mixed success



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