Climate Change Vulnerability and Risk Assessment

Appendix D: Climate Vulnerabilities and Risks by Focus Area

City of Ottawa
Planning, Real Estate and Economic Development Department

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D.1 Agriculture and Food Systems

The Agriculture and Food Systems Focus Area examined climate impacts on the production and distribution of crops and livestock, urban food production (such as community gardens), as well as food security.

The following table include a summary of the noted impacts, vulnerabilities and possible consequences for the Focus Area. Following this table are the impact statements used in the Climate Vulnerability and Risk Assessment (CVRA) along with specific vulnerability / consequence notes and ratings at the City and community scale.

Table D.1 Summary of Focus Area Impacts, Vulnerabilities and Consequences by Climate Hazard Theme

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Extreme Heat, Drought and Humidity 	• Reduced food and agricultural production • Increased irrigation demands and costs • Increased spread of invasive species and pests • Increased health and safety risks to workers • Increased health and safety risks to livestock • Increased occurrence of shallow dry wells • Reduced water quality (algal blooms) • Increased risk of wildfires	• Smaller farms with less access to risk reduction actions (e.g., crop insurance, technologies such as tunnels and shade cloth) due to cost • Monoculture style farms (limited crop rotation) • Farms with poor soil quality • Food industry sectors that rely on low-cost food sources • Workers who may not have access to adequate shade structures and may be incented to work in all conditions	• Increased operational costs (e.g., to invest in adaptive measures and technologies) • Higher risk of insolvency • Higher food costs and reduced local food security • Stress on crop insurance systems • Less people entering the farming sector • Farmlands are sold and become non-productive (e.g., hobby farms) • Loss of soils
Seasonal Variability 	• Reduced food and agricultural production • Increased spread of invasive species and insect pests • Increased health and safety risks to workers • Increased health and safety risks to livestock • Reduced pollinators • Increased tree and ecosystem instability, habitat shifts and/or habitat loss	• Longer but inconsistent growing season (no net benefit to farmers) • Smaller farms who do not have access to risk reduction actions (e.g., crop insurance, technology (e.g., tunnels, shade cloth) due to cost • Farms dependent on municipal drains (e.g., issues with Phragmites which are tall grasses and reeds) • Pollinators have an important role to play in the natural fertilization of crops, fruit trees, etc. Seasonal changes will likely disrupt pollinator lifecycles until a new natural equilibrium is reached.	• Increased operational costs (e.g., invest in adaptive measures and technologies) • Higher risk of insolvency • Reduced local food security and higher food costs • Stress on crop insurance systems • Artificial methods of pollination and/or managed pollinators • Loss of professional farmers

Precipitation Volume and Intensity 	• Delayed planting / harvesting, crop loss or reduced pasture / forage due to saturated agricultural lands • Increased agricultural run-off and sediment loading • Increased soil loss	• Agricultural lands prone to overland or riverine flooding • Downstream landowners • Farms that have difficulty keeping water on the land (e.g. uncovered soil)	• Increased land management and operational costs (e.g. invest in adaptive measures and technologies, increased fertilization due to soil loss) • Reduced food and agricultural production • Pollution of potable water sources and watercourses • Higher risk of insolvency from farms • Higher food costs and reduced local food security • Increased demand for Municipal Drain clean-outs
Extreme Events 	• Reduced food and agricultural production (direct damage) • Electricity or communication interruptions / blackouts • Increased health and safety risks to workers • Increased health and safety risks to livestock • Disruptions to food supply chain	• Farmers operating with losses or low margins • Food industry sectors that rely on low-cost food sources / imports (e.g., secondary and restaurants, etc.) • Livestock farms (electricity outages impact ventilation) • Crop insurance and re-insurance sectors	• Increased insurance premiums • Higher risk of insolvency • Reduced mental health of farmers • Increased repairs to farm infrastructure (tunnel, barns, equipment)
Global Climate Change 	• Disruptions to material and fuel supply chain • Disruptions to food supply chain	• Farmers operating with losses or low margins • Food industry sectors that rely on low-cost food sources / imports (e.g., secondary and restaurants, etc.) • Lack of small and medium scale food processing and distribution infrastructure in the region - abattoirs, commercial kitchens, warehousing, and root cellars – creates a supply chain vulnerability • Labour shortages exacerbate supply chain vulnerability at various stages of food production	• Higher food costs and reduced local food security • Higher risk of insolvency of farms • Reduced seed availability • Soil loss/reduced soil quality

The following table presents a summary of the Agriculture and Food Systems Focus Area Impact Statements. Details on the ratings for each Impact Statements follows below.

Impact Statement		City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
1.	Drought like conditions may result in reduced agricultural yields.	Low Vulnerability						High Vulnerability	High Risk	High Risk	Very High Risk	Very High Risk	Immediate action required.
2.	Hotter summers and variable precipitation may increase irrigation demands at food production and agricultural operations.	Low Vulnerability						Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.
3.	Hotter summers and a prolonged growing season may create conditions that increase agriculture and food production opportunities.	Low Vulnerability						Low Vulnerability					
4.	An increase in summer temperatures may result in additional health and safety risks for agricultural workers.	Low Vulnerability						Medium Vulnerability	Low Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
5.	Hotter and drier summers may increase the risk that agricultural materials stored in bulk (e.g., stored fertilizer, grain in silos, manure piles) catch fire.	Low Vulnerability						Low Vulnerability					
6.	Seasonal changes may disrupt pollinator lifecycles and increase the number of agricultural pests or invasive species resulting in reduced food production.	Low Vulnerability						Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Immediate action required.
7.	Changes in weather patterns may result in more lands suitable for farming operations.	Low Vulnerability						Low Vulnerability					
8.	Warmer and shorter winters may result in less energy needed to heat buildings that house livestock and poultry.	Low Vulnerability						Low Vulnerability					

	Impact Statement	City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
9.	Wetter winters and springs or an increase in the volume and intensity of precipitation may result in saturation or flooding of agricultural lands and reduce pasture availability / forage production or delayed planting/harvesting.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.
10.	Wetter winters and springs could result in natural wetland creation in areas where conditions were previously unsuitable.	Low Vulnerability						Low Vulnerability					
11.	An increase in the volume and intensity of precipitation may cause increased run-off from agricultural lands resulting in nutrient loading of nearby aquatic ecosystems.	Low Vulnerability						Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.
12.	An increase in extreme events (e.g., tornadoes, wildfires, ice storms, etc.) can negatively impact food production and agricultural operations and reduce local food security.	Medium Vulnerability	Low Risk	Low Risk	Low Risk	Medium Risk	Identify possible controls and continue to review for change.	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
13.	Drought like conditions may result in reduced agricultural yields.	Low Vulnerability						High Vulnerability	High Risk	High Risk	Very High Risk	Very High Risk	Immediate action required.
14.	Hotter summers and variable precipitation may increase irrigation demands at food production and agricultural operations.	Low Vulnerability						Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.

1. Drought like conditions may result in reduced agricultural yields.

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Low Vulnerability					
Community	High Vulnerability	High Risk	High Risk	Very High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Farming is expected to get even riskier. While the notional sign that a longer growing season is a good thing, any season lengthening will be offset by more extreme weather events. Additional severity will significantly change the landscape and the food that is produced. • Smaller farms do not always have access to risk reduction actions (e.g., crop insurance, technology (e.g. tunnels, shade cloth) due to cost). • Farmers with low soil organic matter are at increased risk. • A lot of land planning is done ahead of time and there is no way to plan or adapt mid-season for the variability and uncertainty in seasons. • Ventilation systems for livestock will need to be more complex to deal with warmer days. • Tile drains are a double-edged sword in that they are great for wet seasons, but not helpful when farms need to retain moisture in soil during droughts. They may also not be suitable for all topography. • There are new technologies available to better manage water on the land and farmers are likely to explore new control structure technologies as droughts increase but barriers will need to be addressed (e.g., access to technology and how to use). • Getting harder to attract workers into the business (e.g. extreme weather, extreme economic conditions) • Increased concentration of pollutants in water could result in livestock health and safety issues.	• The City is working with Invest Ottawa at the Ottawa Smart Farm, to pilot and validate technologies that can mitigate impacts of climate change on producers. Research is currently focused on yields and emissions from various precision farming methods, but there is interest in expanding the research to also look at impacts (yields and runoff) under different water conditions. • Continue to explore agricultural technologies that can encourage yields in less ideal growing conditions like drought. • The City's Ottawa Rural Clean Water program, delivered in partnership with the Conservation Authorities, offers incentives for best management practices that manage water including technologies such as low till, cover crops, controlled tile drains and precision farming.

2. Hotter summers and variable precipitation may increase irrigation demands at food production and agricultural operations.

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Low Vulnerability					
Community	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Water demand is a major issue. • Greater pressure / requirements for farmers to invest in adaptive measures and technologies to meet increased irrigation demands. • Increased incidence of dry wells (although it is being mitigated by digging deeper).	• Funding from the Ottawa Rural Clean Water Program (up to $5,000) is available for the installation of controlled tile drainage. This technology helps keep moisture in tile drained fields during the growing season.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Increased temperatures and more extreme temperatures mean greater evapotranspiration. • Increased concentration of pollutants could result in livestock health and safety issues.	

3. Hotter summers and a prolonged growing season may create conditions that increase agriculture and food production opportunities.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Rated as Low since this is not an opportunity that farmers will be able to successfully capitalize on. • While average frost free days will be longer, there are more likely to be erratic occurrences of later spring and early fall frosts which do significant damage to the crop. Although the season will be longer and warmer, farmers may well not be able to take advantage of that because the snap frost events will mean plants cannot take advantage of the additional season. • Ottawa has ~1200 registered farms many of which are large scale farms that are likely constantly reviewing their selection of crops. • There is an interest in market gardens (not just high impact crops) • Lack of access to seasonal workers (farm may be ready to seed, but not enough labour pool available)	• Policies that protect agricultural lands from pressures like development/ erosion. • City-supported Smart Farm supports applied research on sustainable agriculture.

4. An increase in summer temperatures may result in additional health and safety risks for agricultural workers.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Medium Vulnerability	Low Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Health and safety risks to workers and reduced productivity. • May see a requirement to ensure shaded / cool areas are available to workers (may increase building footprints). • While labor codes are in place, migrant workers in particular may not have access to adequate shade structures and may be incented to work through breaks. • Attracting workers will be the greatest risk. Labour shortages may exist. The average age of farmers is getting older and fewer new farmers are entering the field.	• None noted.

5. Hotter and drier summers may increase the risk that agricultural materials stored in bulk (e.g., stored fertilizer, grain in silos, manure piles) catch fire.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Not an issue. Little to no examples with modern storage systems.	• Automated monitoring.

6. Seasonal changes may disrupt pollinator lifecycles and increase the number of agricultural pests or invasive species resulting in reduced food production.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• There has been a noted increase in the number of pests and invasive species over the past years, including increased spread of Wild Parsnip and Giant Hogweed. • Phragmites are only starting to become an issue but assume it will increase. They have stems/roots systems that choke up Municipal Drains (and ditches), trap sediment and restrict flows which can result in overland flooding and impact agricultural operations. • Pollinators have an important role to play in the natural fertilization of crops, fruit trees, etc. Any seasonal changes will likely disrupt pollinator lifecycles until a new natural equilibrium is reached.	• It may be necessary to resort to artificial methods of pollination and/or managed pollinators until a new natural equilibrium is reached. • There has been a general increase in the amount of attention given to the importance of pollinators by the public. The City has seen an increase in the number of pollinator garden projects proposed under the Community Environmental Projects Grant Program.

7. Changes in weather patterns may result in more lands suitable for farming operations.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Not a significant opportunity.	• None noted.

8. Warmer and shorter winters may result in less energy needed to heat buildings that house livestock and poultry.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• May result in reduced costs yet heating systems or better building construction will still be required for the extreme temperatures. • Ventilation systems will need to be more complex to deal with the warmer days. This means increased costs.	• None noted.

9. Wetter winters and springs or an increase in the volume and intensity of precipitation may result in saturation or flooding of agricultural lands leading to delayed planting/harvesting and reduced pasture availability / forage production.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
Community	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Increased costs to City and landowners due to additional maintenance (clean-outs) of rural ditches and Municipal Drains. • Increased fertilization application and associated higher costs to farms that lose fertility due to soil loss. • Sediment loading from extreme weather events (especially on bare soils). • Increased farmland cost due to flooding (e.g., reduced supply). • Rain / snow combo on agricultural fields creates problems - not about volume of snow, but how much water is in snow (snow to water equivalent).	• Tile drains are a double-edged sword in that they are great for wet seasons, but not helpful when farms need to retain moisture in soil during droughts. • There are new technologies available to better manage water on the land (barriers will need to be addressed such as access to technology). • Municipal drain maintenance (City role) requested by and paid for by landowners (cost share basis including City portion for any road runoff). • Smart Farm – research on precision agriculture and impacts on yields and emissions; doesn't currently examine variable precipitation or runoff (could explore in future). • Grants available for soil and water management.

10. Wetter winters and springs could result in natural wetland creation in areas where conditions were previously unsuitable.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Low opportunity. • Positive impact on tourism for birdwatching community.	• Rural Clean Water Program has an incentive grant to transition fragile agricultural lands to natural lands.

11. An increase in the volume and intensity of precipitation may cause increased run-off from agricultural lands resulting in nutrient loading of nearby aquatic ecosystems.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Precipitation intensity is very damaging to soil in terms of erosion potential and this impacts water quality. • Increased fertilization application and associated higher costs to farms that lose fertility due to soil loss. • Sediment loading from extreme weather events (especially on bare soils). • Local Agriculture Canada research shows that the increased nutrient loading that comes as a result of the change in distribution of rainfall results in spikes in phosphorus etc. when the heavy rains come. Tile drains do not help or hinder this as they only control subsurface runoff.	• City's Rural Clean Water Program supports Best Management Practices to reduce runoff from agricultural practices.

12. An increase in extreme events (e.g., tornadoes, wildfires, ice storms, etc.) can negatively impact food production and agricultural operations and reduce local food security.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Low Risk	Low Risk	Low Risk	Medium Risk	Identify possible controls and continue to review for change.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Severe wind, hail, unseasonable frosts, freezing rain, tornados, hail, landslides damage crops, lands and operations. • Extreme weather can cause stress, injury and death to livestock. Fire in Vars killed 100 animals that resulted in issues with the disposal of deadstock. • Insurance coverage for losses due to extreme weather may be difficult to obtain. • Can result in increased costs to food industry (secondary and restaurants, etc.) and decreased supply chain reliability. • Electricity grid failures (requiring generators which are expensive).	• None noted.

13. Global climate change may cause supply chain instability and/or market failures impacting availability and the cost of goods and services, including food, resulting in increased pressure those people experiencing poverty, those in precarious economic situations and community services.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.
Community	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• There are storage and processing constraints for food. The seasonality of Ontario fruit/ vegetable production (greenhouse not withstanding) makes it very hard for Ontario-based farms and companies to supply the market. Stockpiling has limitations due to expiration dates and storage costs. • Most non-commodity food trade has consolidated into a supply chain along specialized lines (dairy, meat, eggs, fresh fruit and vegetables and specialty foods) where growers supply packers and distributors who supply highly concentrated retail distribution. National retail food chains need large suppliers to achieve a scale of efficiency that is reflected back down the supply chain to growers. An individual retailer may offer as many as 200 different fruit and vegetable products but use only 2 or 3 suppliers (grower/packer/shipper alliances) for each commodity. This leaves the skill sets and production capacity in very few hands. • In the Ottawa Valley, the vast majority of agricultural producers are engaged in dairy or cash crop operations. These industries require a skill set, equipment inventory and scale of labour force which cannot easily pivot production in the event of a supply chain crisis. Nor does the Ottawa Valley have the hard produce storage capacity in place to hold local inventory or process perishable goods. • There is some milling capacity and abattoir capacity in the area, but insufficient to ensure local market demand. • Historically (prior to WW2) in Ontario, peri-urban market gardens and livestock / poultry production appear to have supplied as much as 50% of the food supply for large urban centres. This disappeared in the 1960's and 1970's as urban sprawl absorbed these farms and the farm families exited agriculture. Today the four leading counties that have an average farm profitability are Essex, Niagara Region, Simcoe and Waterloo Region. Only Waterloo Region has held onto a mixed farming demographic. The others are highly specialised in fruit and vegetable production. • Increased demand and appreciation of local food / regional food movement; increased demand of lands appropriate for food production, seasonal laborers; may result in land conversion. • Lack of small and medium scale food infrastructure - abattoirs, commercial kitchens, warehousing and root cellars create a supply chain vulnerability. • Labour shortages are impacting every stage of food production which creates a supply chain vulnerability. • Increased expectation on farmers to reduce the price of food (but the issue is systemic).	• Partnerships with community partners such as Just Food on promoting buy local and raising awareness of local food security.

D.2 Buildings and Facilities

The Buildings and Facilities Focus Area encompasses residential, commercial, institutional and industrial buildings sectors, both City-owned and privately owned, from site planning and design to operation.

The following tables include a summary of the noted impacts, vulnerabilities and possible consequences for the Focus Area. Following this table are the impact statements used in the Climate Vulnerability and Risk Assessment (CVRA) along with specific vulnerability / consequence notes and ratings at the City and community scale.

Table D.2 Summary of Focus Area Impacts, Vulnerabilities and Consequences by Climate Hazard Theme

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Extreme Heat, Drought and Humidity 	• Increased cooling demands • Reduced indoor air quality in buildings with no or poor cooling • Increased urban island effect	• Community facilities without adequate air conditioning (e.g., churches/ synagogues, private daycares or long-term care centers) • 60% of schools do not have A/C and are not easily retrofitted because of the building envelope, infrastructure and lack of funding • ~20% of Ottawa residents lack A/C access in their homes • Social housing typically only has A/C in common areas • Poorly insulated buildings (e.g. constructed before 1990s) • Building Code has not yet adapted requirements to mitigate increases in extreme heat	• Costs to retrofit buildings with cooling and ventilation • Increased operating costs due to the need for higher/longer use of A/C • Increased waste and GHG emissions • More heat- and smoke-related illnesses and fatalities, especially for disproportionately impacted populations • Loss of worker productivity in inadequately cooled buildings • Canceled City or community programming or services in facilities with no or poor A/C
Seasonal Variability 	• Damaged / compromised buildings (foundational damage, premature deterioration of concrete, roof damage due to ice dams, and moisture damage) • Damaged underground irrigation systems	• Buildings constructed before 1980 (includes much social housing) largely due to construction methods, materials used and historically poor maintenance regimes. • Heritage buildings • Park field houses and community buildings	• Increased cost to manage and maintain buildings

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Precipitation Volume and Intensity 	• Damage to buildings from overland / riverine flooding (roof and foundation damage, water ingress) and sewer-related damage (backups) • Reduced access to buildings and facilities • Flood damage to private wells and septic systems	• Properties within the floodplain (e.g., Britannia and Lemieux Water Purification Plants, Ottawa Rowing Club) • Approximately 300 – 400 homes were impacted by Ottawa River flooding in 2017 and 2019 • Residential lots adjacent to ravines at risk of erosion (e.g., Bilberry Creek, Mosquito Creek) • Heritage and older buildings (more susceptible to water ingress) • Properties in low-lying areas • Private wells and septic systems in flood-prone areas	• Increased repair and replacement costs • Interruption/ impacts to services • Financial hardship and displacement of populations • Higher insurance premiums • Decrease in property value for homes in flood plains • Increased cost of housing • Increased costs to respond to flood events, more support for residents dealing with flooding and staff redeployment from other departments to support the response • Increased waste (from damaged buildings)
Extreme Events 	• Damaged / compromised buildings • Electricity or communication interruptions / blackouts	• Buildings under construction • High rise buildings and their tenants • Exposed roof-top mechanical systems • Most City facilities and buildings have back-up electricity for limited lighting and some critical systems • Private and public buildings with sump pumps and no back-up electricity	• Compromised building functionality and/or loss of use • More frequent unplanned repairs and renewals and associated costs • Loss of housing/facilities and associated mental health impacts • Increased insurance premiums • Increased waste (from damaged buildings)
Global Climate Change 	• Increased material costs for construction • Disruptions to material and fuel supply chain	• Construction sector • Lower income populations	• Increased costs to long-term projects and budgets • Delayed construction of City and community buildings due to cost increases which could lead to an increase in the deterioration of existing City building stock. • Increased capital costs may result in a scaling back of community programming

The following table presents a summary of the Buildings and Facilities Focus Area Impact Statements. Details on the ratings for each Impact Statements follows below.

Impact Statement		City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
1.	Unusually hot temperatures and/or high humidex periods may result in an increased demand for upgrading buildings and facilities.	Medium Vulnerability	Medium Risk	Medium Risk	High Risk	High Risk	Develop a plan to address risk.	Medium Vulnerability	Medium Risk	Medium-High Risk	Very High Risk	Very High Risk	Immediate action required.
2.	Warmer and shorter winters may result in a reduction of building heating requirements.	Low Vulnerability						Low Vulnerability					
3.	Changing winter temperatures and more freeze-thaw events in the winter may result in more frequent repairs and renewals to buildings.	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Immediate action required.	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Develop a plan to address risk.
4.	An increase in the volume and intensity of precipitation may cause riverine flood-related damage to buildings.	High Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	High Risk	Immediate action required.	High Vulnerability	Medium-High Risk	High Risk	High Risk	Very High Risk	Immediate action required.
5.	An increase in the volume and intensity of precipitation may overwhelm sewer systems and cause flood-related damage to buildings.	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.
6.	An increase in the volume and intensity of precipitation may compromise roof and foundation drainage	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required.
7.	An increase in wind speeds and extreme weather events (including lightning and tornadoes) may result in damages to existing buildings and those under construction/renovation.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium-High Risk	Identify possible controls and continue to review for change.

Impact Statement		City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
8.	An increase in multi-day ice storm events may increase the number of extended power outages affecting building and facility operations.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Develop a plan to address risk.
9.	Increased annual temperatures, shifting seasons and extreme events may require additional protection measures in community plans, site plans and building design (e.g., shade, stormwater management, emergency refuge areas).	Medium Vulnerability	Medium Risk	Medium Risk	Medium -High Risk	High Risk	Develop a plan to address risk.	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
10.	Global climate change may cause supply chain instability and/or market failures impacting the availability of goods required to maintain City buildings.	Medium Vulnerability	Medium Risk	Medium Risk	Medium -High Risk	High Risk	Develop a plan to address risk.	Low Vulnerability					

1. **Unusually hot temperatures and/or high humidex periods may result in an increase demand for upgrading buildings and facilities.**

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Medium Vulnerability	Medium Risk	Medium Risk	High Risk	High Risk	Develop a plan to address risk.
Community	Medium Vulnerability	Medium Risk	High Risk	Very High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	**Adaptive Responses In Place**
• Costs to retrofit buildings with cooling and ventilation • Increased operating costs due to the need for higher / longer use of A/C • Heat is a significant problem that can lead to a wide range of health impacts. The cost of not adapting buildings to allow for greater cooling is increased health impacts, especially for seniors and people with disabilities. • Forced reductions to productivity and/or working hours as buildings become inhospitable to workers, requiring increased breaks or changes to work conditions • Canceled City or community programming or services in facilities with no or poor A/C • Approximately 20% of floor area of City buildings have A/C • The community may have less means to respond to higher cooling demands. • Approximately 20% of residents lack good A/C access (provincial estimates). • 60% of Ottawa's schools do not have A/C and are not easily retrofitted because of the building envelope, infrastructure and funding. This is an increasing problem with more heat expected in spring leading to more community use. • Many churches, synagogues and other community buildings do not have A/C or have ineffective / inefficient A/C. Impacts summer programming. • 15,000 Ottawa Community Housing (OCH) units are in mid- and high-rise buildings which provide a common cooled area but do not have central A/C. • HVAC systems tend to be oversized and inside design temperatures are only hard to meet for a few days when temp is above 35^{o}C. Humidity also plays a major factor since fresh air must be dehumidified. • Design of HVAC system is often the problem. Inconsistent cooling makes community rooms unuseable and is an issue for health and safety. • Local recreational facilities are critical for many community members, including seniors and parents with young children. Communities without sufficient recreational facilities will lead to increased strains on the health care system. • Low-income individuals / families cannot access services with A/C like fitness centres, movie theatres etc. due to costs. • Residents, especially low-income residents, often look to community centres, libraries and other public buildings as destinations to cool down. When these centres do not offer air conditioning, they reduce their suitability for other uses, such as indoor recreation opportunities. Residents may be forced to seek out other sources of A/C, such as malls and retail stores, which provide challenges (i.e., private environments are often 'pay to stay' and if someone is not shopping or making purchases, they may not be welcome). • There is a shortage in talent/trades which will hinder the City / community's ability to adapt using new technologies. • Increased outdoor temperatures are expected to increase smog, ozone and allergens which can also impact indoor & outdoor air quality.	• Most City facilities have A/C • The Peter D Clark Long Term Care facility will be retrofitted to add humidifiers, sprinklers and A/C by 2023 • Facility Management Framework will improve management of City Facilities • Deep retrofits are underway for 12 Ottawa Community Housing communities (2,400 units) and by 2028 there will be provided with cooling through heat pumps. • The New Official Plan, the High-Performance Development Standard and the Municipal Green Building Policy is addressing the need to reduce the urban heat island effect through cool or green roofs, light coloured reflective materials, retention of mature trees, tree planting, and other urban greening.

2. Warmer and shorter winters may result in a reduction of building heating requirements.

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Heating energy use may drop due to lower heating degree days but overall this is seen as a low opportunity. • New building designs and building retrofits need to pay greater focus to heating to cooling change overs. • Some recreation facilities will have additional planning, maintenance and lifecycle needs as winters warm (e.g., Canterbury refrigerated rink). Planning and capital issues will arise as refrigerated rinks need a very different electrical setup.	• Facility Operations is working to ensure new and replacement equipment meets evolving standards. • Facility Management Framework will improve management of City Facilities.

3. Changing winter temperatures and more freeze-thaw events in the winter may result in more frequent repairs and renewals to buildings.

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Immediate action required.
Community	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Possible increased maintenance or repair for facades, roofing systems, seals and hardscaping. • Building envelope remediation is an ongoing asset management concern which will be exacerbated by increased freeze-thaw (need to determine when it's no longer worth repairing). Delays to infrastructure upgrades and repairs will result in amplified costs further down the road. • Damage to infrastructure will likely have significant effects on buildings coming to the end of their life cycles. Buildings such as social housing, largely constructed before 1990, are likely to see significant impacts. • Challenge between building performance standards set by City (City has LEED Silver goal and is pursuing higher standards through the High-Performance Development Standard) and standards set at the Provincial / Federal level. • Increased pressure to switch from traditional materials to contemporary ones for heritage buildings (e.g. how to accommodate requests for new materials, how to make these types of alterations appropriate / compatible with the reasons a property is protected / important, etc.). • Limited economic impact to city by not having facilities available to run programs etc. • Could have major impacts if municipal works garages/ administrative buildings are impacted.	• Facility Operations is working to ensure new and replacement equipment meets evolving standards. • Facility Management Framework will improve management of City Facilities

4. An increase in the volume and intensity of precipitation may cause riverine flood-related damage to buildings.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	High Risk	Immediate action required.
Community	High Vulnerability	Medium-High Risk	High Risk	High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• ~300-400 homes in West Carleton, Cumberland and Britannia communities impacted by Ottawa River flooding in 2017 and 2019. • City properties within the floodplain (e.g. Water Purification Plants, Ottawa Rowing Club) may be damaged, or may require a permanent alteration. • Difficult to deliver services and programs if loss or damaged building due to flooding. This will increase the risk of being able to respond to emergencies with loss of community buildings and works yards. • Information gaps remain for areas and buildings that are most vulnerable (e.g., buildings at risk along smaller tributaries). • Resources diverted to flood response pose a risk to other City activities. • Substantial resources may be required for the community to adapt. Emergency management plans and policies will require updates. • Increased waste collection (damaged buildings).	• Flood response plans in place for City's two drinking water purification plants (following 2017 and 2019 floods); long-term permanent solutions being identified in Comprehensive Development Plans (expected 2022). • Flood mitigation structures (e.g. berms) in Britannia and along Rideau River • Coordinated emergency response (e.g., food, shelter, transportation; opening community centers/ respite centers). • Flood mapping available on City website for several flood events, including for a more severe flood under climate change. • Policies in the new Official Plan require flood risk mitigation to a 1:350 riverine flood for new development. • Facility Management Framework will improve management of City Facilities

5. Heavy rains may overwhelm sewer systems and cause flood-related damage to buildings.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.
Community	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Historical flooding resulted in exposure to septic waste, damage to buildings and mold exposure. • Areas prone to flooding have increased. These areas are typically serviced by older or partially combined stormwater systems with poor drainage, or areas where there is increased densification or infill. • This impact is likely to be compounded by intensification. Zero lot line developments may	• Residential Protective Plumbing Program • Compassionate grant program for sewer back-ups. • Coordinated emergency response (e.g., food, shelter, transportation; opening community centers/ respite centers). • Policies in the new Official Plan require consideration of future rainfall in site planning and infrastructure design; on-site management of stormwater. • Zoning By-Law sets minimum requirements for soft landscaping.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
affect drainage, particularly in the urban core (less permeable surfaces for drainage). • Risk of damage to historic properties, costs to repair or alter to avoid future damage. • Many residential insurance policies do not cover overland flooding / sewer back ups. • Economic impact to the City will be great for infrastructure upgrades to address higher flows and floods, and in emergency response.	• Facility Management Framework will improve management of City Facilities • The City has the Rain Ready Program that provides incentives to private property owners for stormwater mitigation. • The Infrastructure Master Plan is examining the combined effects of increased impermeability with future rainfall to determine impacts on stormwater management systems in greenfield and existing neighbourhoods.

6. An increase in the volume and intensity of precipitation may impact roof and foundation drainage systems resulting in water ingress and damage.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
Community	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Increased roof replacement costs, higher standard of repair, and shorter lifecycle. • Risk that already compromised systems will be more highly exposed (e.g. many of the City's building assets are older and in poor condition and prone to water damage) • Many City buildings have basements, but do not have sump-pumps. • Can lead to facility loss, and cancelled programs / services.	• Facility Management Framework will improve management of City Facilities.

7. An increase in wind speeds and extreme weather events (including lightning and tornadoes) may result in damages to existing buildings and those under construction/renovation.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium-High Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Property damage/ loss of housing and inability to replace due to lack of insurance. • Risks are elevated for buildings being renovated / constructed from displaced materials / moving scaffolding (and construction workers). • Multi-unit residential buildings constructed in the 1980s and earlier are more at risk. • Use of more building materials, clean up contributed to more material in landfill and more material needed to be manufactured to rebuild.	• Urban design guidelines for high-rise buildings may require consideration for the design of the tops of high-rise buildings, particularly with respect to the safe integration of mechanical equipment on the rooftop. • Facility Management Framework will improve management of City Facilities

8. An increase in multi-day ice storm events may increase the number of extended power outages affecting building and facility operations.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
Community	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Most City facilities and buildings have back-up power for limited lighting and some critical systems. • Many commercial buildings have some back up power (lacking data). • Power outages longer than a day are a problem (e.g., food loss; relocating people in extreme temperatures (hot or cold). • Power outages are further complicated when there are compounding events (e.g., sump pumps do not work when an outage occurs during a flood, or outages during extreme temperatures). • It is estimated that 1/3 of the sump pumps at City facilities do not have back up power (more in community centres). • Most homeowners do not maintain sump pumps systems or do not have battery backup. • Heritage assets are more likely to be impacted by ice / cold (due to limitations related to HVAC and insulation) • Some environmental impacts and health impacts from people using alternate higher emissions sources for heat and power.	• The City is reviewing the need for generator adaptability to facilities that may be needed in the case of severe weather events, and reviewing contracts with service operators' contractors to ensure these events are captured in their contracts. (e.g., diesel fuel delivery) • Residential Protective Plumbing Program includes grants for sump pumps with back-up power • Facility Management Framework will improve management of City Facilities

9. Increased annual temperatures, shifting seasons and extreme events may require additional protection measures in community plans, site plans and building design (e.g., shade, stormwater management, emergency refuge areas).

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Building design needs to mitigate hotter temperatures (e.g., green roofs, windows that open). • Green roofs need to be informed by local research to balance urban heat island mitigation (UHI) and other roof uses (e.g. depending on the height of the building it may not make a real difference to UHI versus the co-benefits of other roof uses like solar Photo Voltaic).	• The New Official Plan (OP) is addressing the need to reduce the UHI effect through cool or green roofs, light coloured reflective materials, retention of mature trees, tree planting, and other urban greening.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Operable windows support passive cooling in power outages and for buildings without A/C. However, operable windows in public buildings are problematic from an energy conservation perspective. • Resiliency measures may not be compatible with heritage buildings (large ventilation systems, vents, ac units attached to building). • Higher costs.	• New OP policies also recommend amenity areas be designed to support occupants during an extreme event. • The High Performance Development Standard includes resiliency measures and is expected to be launched in 2022 • An update to the Municipal Green Building Policy is planned for 2022

10. Global climate change may cause supply chain instability and/or market failures impacting the availability of goods required to maintain buildings.

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Supply chain issues are likely to exacerbate challenges in maintaining or retrofitting buildings.	• None noted.

D.3 Community Well-Being and Health

The Community Well Being and Health Focus Area examined climate impacts on a range of services provided to support community health and well being, with a particular focus on vulnerable populations. Climate change is expected to disrupt services like water, transportation, food, communication or electricity and impact physical, mental and social health and safety, as well as financial well-being. While climate change will affect everyone, some populations are more vulnerable to the impacts, and less able to recover. Disproportionately affected populations include, but are not limited to, seniors, children, people living on low incomes, people experiencing homelessness or vulnerable housing, and people with existing health conditions.

The following tables include a summary of the noted impacts, vulnerabilities and possible consequences for the Focus Area. Following this table are the impact statements used in the Climate Vulnerability and Risk Assessment (CVRA) along with specific vulnerability / consequence notes and ratings at the City and community scale.

Table D.3 Summary of Focus Area Impacts, Vulnerabilities and Consequences by Climate Hazard Theme

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Extreme Heat, Drought and Humidity 	• Increased severity of heat-related health and safety issues • Increased health and safety risks for athletes, active recreation participants and active transportation users • Increased risk of food-borne illnesses • Increased demand for community cooling amenities such as splash pads, pools and beaches • Additional strain / reduced capacity of emergency response and social support systems (e.g., paramedics) • Increased risk of wildfires and poor air quality	• Health risk is based on sensitivity, exposure and other factors such as age, sex, gender, ethnicity, race, being a member of indigenous populations, mental health, chronic diseases, pregnancy, medication use, substance misuse, occupational exposure, and exposure to urban heat islands. • Individuals with pre-existing physical and mental health conditions or who have mobility barriers, the very young and older adults, pregnant women. • Individuals that spend a significant amount of time outdoors, such as children, youth, athletes, and especially outdoor workers • Households with limited financial resources (homes with less insulation or lack A/C, cannot afford to run A/C systems, cannot access many services with A/C)	• More heat- and smoke-related illnesses and fatalities, especially for disproportionately impacted populations • Decrease in outdoor recreation and sports, leading to poorer physical and mental health • Overwhelming of hospitals and social services • Increased climate control expenses • Cancellation or postponement of outdoor public events (e.g. sports, festivals) • Lost workdays due to extreme heat (e.g. outdoor workers) • Increased demand for libraries and community centers as cooling centers, especially in at-risk neighborhoods • Reduced beach / recreational access due to health hazards (algal blooms) • Increased wildfire management requirements and costs • Increased demands on emergency response and social services

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
		• 19% of residents lack A/C access (81% of Ottawa residents had some form of AC in 2019)[1] • Individuals experiencing homelessness or who are precariously housed • People living in smaller spaces • People who lack access to green space • Immigrant communities, linguistically isolated persons • Rural communities adjacent to areas at risk of wildfire, with limited water for firefighting	
Seasonal Variability 	• Increased risk of disease vectors and illnesses spreading (e.g., Lyme disease, West Nile virus) • Increased slips and falls from more winter freeze-thaw	• Park users and recreationalists • Outdoor workers • Older adults and people with mobility challenges	• Reduced health and safety • Increased pressure to maintain parks and address public health and safety risks • Increased insurance claims to the City for slip and falls, resulting in higher payouts and higher insurance premiums.
Precipitation Volume and Intensity 	• Physical, mental, and financial impacts from overland / riverine flooding and sewer-related damage • Isolation of residents / reduced access to affected communities • Increased demands on emergency response and social support systems	• Communities within the Ottawa River floodplain (~300–400 homes in West Carleton, Britannia, and Cumberland affected in 2017 and 2019) • Communities located within the Rideau River flood plain (e.g. near Brewer, Brantwood and Windsor parks, Vanier) • Lower income households may not have insurance nor be able to find alternative accommodations • People injuring themselves trying to keep their homes safe • Basement apartments in low-lying areas subject to flooding and sewer back up in heavy rains	• Financial hardship and displacement of populations • Physical and mental impacts to community members, especially for disproportionately impacted populations • Increased demand for / use of community services, like food banks • Losing access to childcare, work, etc. if people are required to leave their community to seek relief from flooding • Increased pressure on emergency responders • Increased pressure on building inspection • Decreased property value for homes in flood plains

[1] Statistics Canada. Table 38-10-0019-01 Air conditioners https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3810001901andpickMembers%5B0%5D=1.24andcubeTimeFrame.startYear=2017andcubeTimeFrame.endYear=2019andreferencePeriods=20170101%2C20190101

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
		• Emergency services can be stretched as they respond to the flood impacts, while maintaining continuity of operations	• Damage to underground infrastructure (telecom, gas etc.) and danger to residents if water reaches electrical panels in basements of homes (2019 flood event – had to shut off electricity to various dwellings) • Exposure to septic waste; damage to buildings and mold exposure.
Extreme Events 	• Physical and mental health impacts, and financial impacts • Increased demands on emergency response and social support systems • Electricity or communication interruptions / blackouts • Damaged / compromised critical infrastructure assets (water / wastewater, health) • Isolation of priority populations	• Disproportionately impacted populations such as Indigenous Peoples, older adults, low income, homeless, and racialized people • More remote rural populations who may be cut off from roads / utilities • Persons with disabilities / mobility issues (homebound as they wait for snow and ice clearing) • Increased anxiety in communities that have experienced past emergencies (i.e. West Carleton experiencing floods and tornado) • First responders • Social service agencies • Response during concurrent events (e.g. winter storm and electricity outage; flooding and electricity outage) • Persons without insurance, or inadequate insurance (ex: no flood coverage)	• Increased health and safety risks (physical and mental) • Financial hardship and displacement • Increased risk of isolation • Increased demands on emergency response and social services • Increased disruption to all City operations and business continuity (re-deployment of staff) • Overwhelming of hospitals and social services • Increased demand on emergency responders, impacts on staff health, staff shortages • Increased claims to City for slip and falls, resulting in higher payouts and higher insurance premiums • Extended communications outages, such as during the 2019 Tornado event
Global Climate Change 	• Supply chain breakdowns (e.g., food, fuel, other goods) causing increased costs • Increased migration to Ottawa (climate refugees / immigrants)	• Populations that depend on community services (e.g. food banks, social assistance) • Additional households / families may require social assistance • Lack of capacity in social systems, especially for mental health and complex cases	• Increased pressure on community services including social housing, food banks, mental health or subsidized transit • Increased inequality and families pushed to poverty and homelessness • Increased costs may result in a scaling back of community programming • Emergency response to receive refugee populations that have been determined a priority by the federal government

The following table presents a summary of the Community Well-Being and Health Focus Area Impact Statements. Details on the ratings for each Impact Statements follows below.

	Impact Statement	City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
1.	Unusually hot temperature and/or high humidex periods may increase the number and severity of heat-related health and safety issues, particularly for populations at risk such as infants, children, older adults, people who work and exercise outside, active transportation users, people experiencing homelessness, those with existing health conditions, and those without good access to air conditioning. Mental and social aspects may also be negatively impacted.	Medium Vulnerability	High Risk	Very High Risk	Very High Risk	Very High Risk	Immediate action required.	Medium Vulnerability	High Risk	Very High Risk	Very High Risk	Very High Risk	Immediate action required.
2.	Unusually hot temperature and/or high humidex periods may lead to less outdoor recreation and sports impacting overall physical and mental health of the community.	Low Vulnerability						Medium Vulnerability	Medium-High Risk	High Risk	High Risk	High Risk	Immediate action required.
3.	Hotter and drier summers may increase the likelihood of wildfires which can increase the concentration of airborne pollutants and result in adverse health risks to the community.	Low Vulnerability						Low Vulnerability					
4.	Increased heat in late summer and early fall will create more opportunities for Legionalla bacteria to grow resulting in more people getting Legionella disease and Pontiac Fever	Low Vulnerability						Low Vulnerability					
5.	Warmer and shorter winters and extreme winter events may stress and hamper wildlife migration patterns resulting in an increase in encounters to domestic to wildlife, wildlife to wildlife, wildlife to domestic, and humans to wildlife and humans to domestic.	Low Vulnerability						Low Vulnerability					
6.	An increase in seasonal temperatures and extended warm weather may result in a change of behaviour where food is brought outdoors which results in an increased risk of food-borne illnesses due to inadequate holding temperatures for food from the growth of pathogens.	Low Vulnerability						Low Vulnerability					

	Impact Statement	City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
7.	An increase in seasonal temperatures may increase the likelihood of poor air quality (e.g., ozone, allergens) leading to additional respiratory illnesses and allergic reactions.	Low Vulnerability						Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
8.	Changing winter conditions may increase the number and severity of extreme cold-related health and safety issues (slips and falls, isolation, etc.).	Medium Vulnerability	High Risk	High Risk	Very High Risk	Very High Risk	Immediate action required.	Medium Vulnerability	High Risk	High Risk	Very High Risk	Very High Risk	Immediate action required.
9.	An increase in the volume and intensity of precipitation may cause riverine flood-related damage to buildings and expose vulnerable segments of the population to physical injuries, respiratory, water-borne and food-borne illnesses, and mental health impacts.	Medium Vulnerability	Medium Risk	Medium -High Risk	Medium -High Risk	High Risk	Develop a plan to address risk.	High Vulnerability	Medium Risk	Medium -High Risk	Medium-High Risk	High Risk	Immediate action required.
10.	An increase in the volume and intensity of precipitation may overwhelm sewer systems and cause flood-related damage to buildings and expose vulnerable segments of the population to physical injuries, respiratory, water-borne and food-borne illnesses, and mental health impacts. (non-riverine flooding)	Medium Vulnerability	Medium Risk	Medium Risk	Medium -High Risk	High Risk	Develop a plan to address risk.	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required.
11.	An increase in multi-day ice storm events may cause damage to power infrastructure resulting in more frequent and prolonged power interruptions / blackouts and may result in extreme cold-related illnesses / exposure and hazards.	Low Vulnerability						High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Develop a plan to address risk.
12.	An increase in the frequency and intensity of extreme weather events may negatively impact the delivery of essential services (e.g., power supply, food banks, mental health supports, etc.).	Medium Vulnerability	Medium Risk	Medium Risk	Medium -High Risk	High Risk	Develop a plan to address risk.	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required.

Impact Statement		City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
13.	Global climate change may cause supply chain instability and/or market failures impacting availability and the cost of goods and services, including food, resulting in increased pressure those people experiencing poverty, those in precarious economic situations and community services.	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.

1. **Unusually hot temperature and/or high humidex periods may increase the number and severity of heat-related health and safety issues, particularly for populations at risk such as infants, children, older adults, people who work and exercise outside, active transportation users, people experiencing homelessness, those with existing health conditions, and those without good access to air conditioning (A/C). Mental and social aspects may also be negatively impacted.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	High Risk	Very High Risk	Very High Risk	Very High Risk	Immediate action required.
Community	Medium Vulnerability	High Risk	Very High Risk	Very High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• More heat-related illnesses and fatalities, especially for vulnerable populations such as very old and young, those who work outdoors, with pre-existing health conditions, those precariously housed and particularly those with poor access to A/C. • There is an increased need for cooled spaces but single purpose cooling centres are often underutilized due to their limited functionality (e.g., people prefer to go to libraries, wading pools, malls, etc.). • Population demographics greatly affect consequences. Low-income individuals / families often don't have A/C or can't pay for it; and cannot access services with A/C like fitness centres, movie theatres etc. due to costs. • 19% of residents lack A/C access (81% of Ottawa residents had some form of AC in 2019).[2] • Many churches, synagogues and other community buildings do not have A/C or have ineffective A/C. • 60% of Ottawa's schools do not have A/C and are not easily retrofitted because of the building envelope, infrastructure and funding. This is an increasing problem with more heat in spring and more community use. • Ottawa Community Housing mid- and high-rise buildings provide a common cooled area but do not have central A/C (~15,000 units). • Some City facility A/C systems are ineffective. • Summer programming may be affected in buildings with inadequate cooling. • Higher operating costs for higher / longer use of AC (including for social housing providers). • Some heat events are short lived with few impacts on public health and others are prolonged and require education, surveillance, and response by Ottawa Public Health, City departments and community partners.	• Ottawa Public Health (OPH) conducts syndromic surveillance during heat warnings to determine if preventive actions in place are sufficient to protect human health. • The Extreme Heat, Cold and Smog Plan for the City of Ottawa ensures the integration of prevention, mitigation and preparedness via risk monitoring and early warning to inform local service providers and partners in health and emergency management to guide their actions as an early intervention to heat, cold and smog. • OPH is in the process of updating who is at risk during hot weather in a Climate Change and Health Vulnerability Assessment to inform further actions to reduce the effects of climate change on extreme heat, vector borne disease, water and foodborne illnesses, air quality and stratospheric ozone. • The new Official Plan (OP) and draft Transportation Master Plan include policies to provide shaded walking, cycling and transit facilities, to enable sustainable transportation to remain safe and comfortable even on hot days • Staff training / developing heat management plans / investment in capital (A/C systems in Long-term Care facilities). • Building Condition Assessment & Energy Audit Reports being completed at City long-term care facilities • New draft OP includes provisions for more shade (natural/structural) and a 40% tree canopy target. • Deep retrofits underway for 12 Ottawa Community Housing communities (2,400 units) to provide cooling through heat pumps by 2028.

[2] Statistics Canada. Table 38-10-0019-01 Air conditioners https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3810001901andpickMembers%5B0%5D=1.24andcubeTimeFrame.startYear=2017andcubeTimeFrame.endYear=2019andreferencePeriods=20170101%2C20190101

2. Unusually hot temperature and/or high humidex periods may lead to less outdoor recreation and sports impacting overall physical and mental health of the community.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Medium Vulnerability	Medium-High Risk	High Risk	High Risk	High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Childhood development and older adults are especially negatively impacted. • While the fittest individuals are likely to find ways to mitigate the risks, often by simply shifting their activity to late evening or early morning, for those who are less fit, this may be a reason to avoid physical activity altogether. • Narrower opportunity to utilize the outdoors which could impact timing of outdoor athletic events. • Sports clubs do not all cancel or alter outdoor programming in heat events and they may increasingly need to. • Low income tenants in social housing could find themselves even more isolated if low cost / free outdoor community activities are not able to happen due to increases in high temperature days. The health and mental health strain of being isolated from your community can cause issues throughout a family unit.	• The new Official Plan and draft Transportation Master Plan include policies to provide shaded walking, cycling and transit facilities, to enable sustainable transportation to remain safe and comfortable even on hot days. • Ottawa Public Health (OPH) conducts syndromic surveillance during heat warnings to determine if preventive actions in place are sufficient to protect human health. • The Extreme Heat, Cold and Smog Plan for the City of Ottawa ensures the integration of prevention, mitigation and preparedness via risk monitoring and early warning to inform local service providers and partners in health and emergency management to guide their actions as an early intervention. • The Extreme Heat, Cold and Smog Planning Committee is made up of City and community partners with the objectives of encouraging the community and service providers to take actions to reduce health issues relating to extreme heat, cold, and outdoor air quality.

3. Hotter and drier summers may increase the likelihood of wildfires which can increase the concentration of airborne pollutants and result in adverse health risks to the community.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Brush fires within the City of Ottawa and those originating outside of the City of Ottawa can impact residents with smoke. There have been small, localized brush fires yearly within the City of Ottawa e.g. Kanata brush fire April 2021 behind Springcreek Crescent. • May place increased demands on hospitals and physicians attend to people with a need for medication or acute care (cardiovascular and respiratory impacts)	• Ottawa Public Health monitors the media for community impacts and have messaging ready in the event that the air quality on a community-wide basis is impacted or when Ottawa Fire Services asks for assistance.

4. Increased heat in late summer and early fall will create more opportunities for Legionalla bacteria to grow resulting in more people getting Legionella disease and Pontiac Fever.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Legionalla bacteria can become a health concern when they grow and spread in building water systems like cooling towers, decorative fountains and water features. • Warming temperatures increase the risk for spreading Legionella. The disease favors warm and wet environments and can spread via aerosolized bacteria, especially in the summer and autumn. • Home and car A/C units do not use water to cool the air, so they are not a risk for Legionella growth. • Not all building managers have preventive maintenance programs in place.	• Ottawa Public Health liaises with the Federal Government, Outaouais Public Health (CISSSO) and building managers on preventive strategies and investigations of potential legionella outbreaks (e.g. letters to Building Managers regarding the Legionella risk and the need to perform routine maintenance and monitoring).

5. Warmer and shorter winters and extreme winter events may stress and hamper wildlife migration patterns resulting in an increase in encounters to domestic to wildlife, wildlife to wildlife, wildlife to domestic, and humans to wildlife and humans to domestic.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• There are related public health and safety hazards (e.g. risk of rabies, physical injuries of bites (requires tetanus shots), and any new diseases of concern for Ottawa like the Hanta virus). Bats are coming out of hibernation in the winter with changes in temperature. • Suburban expansion is impinging on wildlife territories and increasing the number of encounters between human and domestic animals and wildlife. • There are more wildlife encounters with domestic pets and humans that involve bite injuries requiring follow-up for rabies assessments. • More needs to be done around bite prevention for both domestic and wild animals.	• Ottawa Public Health (OPH) assesses and investigates animal bites and does follow-ups for domestic pets and human exposures to determine and mitigate the risk of contracting rabies. This could include providing Rabies Post-Exposure Prophylaxis. All zoonotic diseases are followed up on by OPH as required by the provincial diseases' regulation (O. Reg. 135/18). • OPH uses social media messaging to make the public aware not to approach or feed wild animals and how to behave around domestic animals to prevent bites.

6. **An increase in seasonal temperatures and extended warm weather may result in a change of behaviour where food is brought outdoors which results in an increased risk of food-borne illnesses due to inadequate holding temperatures for food from the growth of pathogens.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• There has been an increase in the number of outdoor food vendors at outdoor festivals and markets requiring public health inspections for food safety. • 42% of foodborne illnesses occur in the home. There is a steep increase in the number of illnesses between May and October. • There is a marked increase in foodborne illnesses during warm weather in Ontario based on evidence from Public Health Ontario. The Enteric Zoonotic Infection group will follow-up on any reportable foodborne illnesses. • Poor temperature control is far more likely to result in unreported illnesses on a smaller scale, though these are still unpleasant for those who experience it, and can result in lost work days, hospitalization and other disruptions.	• Ottawa Public Health (OPH) Public Health Inspectors work with event organizers to ensure safe food handling practices are followed, and events and food vendors are inspected. • OPH does outreach via social media posts about picnic safety and articles on home food safety. OPH encourages people to take with food handler safety courses.

7. **An increase in seasonal temperatures may increase the likelihood of poor air quality (e.g., ozone, allergens) leading to additional respiratory illnesses and allergic reactions.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Naturalized spaces mean more ragweed issues for By-law, Recreation, Cultural and Facility Services and Public Works to deal with. The City is not in compliance with the Weed Control Act, particularly with respect to ragweed. • Understanding local air quality issues is expected to become a bigger issue in the future. • Respiratory impacts of poor air quality have a disproportionate impact on low-income individuals, on older adults and on young children. These groups are often unable to seek relief from poor air quality, and/or face more pronounced effects from poor air quality. Air quality causes disproportionate harm to these communities and addressing it is an equity issue, especially as pollutants from personal and recreational vehicles, outdoor power equipment (e.g., leaf blowers), and other factors often harm the people who use these technologies the least	• Ottawa Public Health (OPH) monitors the rates of illness associated with poor AQ (cardiovascular and respiratory diseases) in the community and educates / raises awareness about the issue and ways to reduce exposure to air pollution and causes to air pollution. • OPH works with community partners who work on energy efficiency and reducing air pollutants to develop strategies to mitigate and adapt to the effects of air pollution (tree canopies, active transportation routes, public transit, lowering carbon footprints).

8. Changing winter conditions may increase the number and severity of extreme cold-related health and safety issues (slips and falls, isolation, etc.).

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	High Risk	High Risk	Very High Risk	Very High Risk	Immediate action required.
Community	Medium Vulnerability	High Risk	High Risk	Very High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• This has reduced access to facilities for clients. • Severe cold weather can affect persons with mobility issues from being able to freely move from their units. Long-term Care residents are unable to go outside to exercise or participate in activities safely during extremely cold days. • Those in rural areas are more impacted during freezing rain (e.g. less transportation options). • Can lead to the isolation of priority populations. There is also a danger for severe illness and consequences to individuals. • Frostbite and hypothermia result in injuries / deaths in older adults and people with addiction issues. • Some of these events are short lived with few impacts on public health; others are prolonged and require education, surveillance, and response by Ottawa Public Health, City and community partners. • Could result in increased claims to City for slips and falls. For outdoor workers, may be increased Workplace Safety and Insurance Board (WSIB) claims and increased safety issues (for example when a paramedic has to get a patient into an ambulance). • Possible electrical issues and/or increased costs due to longer / more frequent use of small heating equipment in units. • Any issue (power outages for instance) that happens in winter quickly cascades into a series of other issues that may not be as difficult to deal with in better weather.	• More resources have been placed on mitigating the risk of slips, trips and falls. • The City's Social Housing program is funding accessibility projects that will improve movement during harsh winters. • Ottawa Public Health (OPH) conducts syndromic surveillance of climate-related health conditions (heat related illnesses, vector-borne diseases, injuries associated with extreme weather events) to ensure preventive actions are in place to protect human health. • Under the Extreme Heat, Cold and Smog Plan for the City of Ottawa, OPH staff assist service providers to develop resiliency plans for smog, and extreme heat and cold. The plan ensures integration of prevention, mitigation and preparedness via risk monitoring and early warning to inform local service providers and partners in health and emergency management to guide their actions as an early intervention. • OPH has environmental health education, awareness and response plans to reduce climate related illnesses and deaths associated with ultra violet radiation, extreme heat and humidity, cold weather, poor air quality (including wildfire smoke), flooding, Lyme disease and West Nile virus. • The Community Paramedicine Program supports seniors and disproportionately impacted populations who are living at home, reducing the need for emergency paramedic services

9. An increase in the volume and intensity of precipitation may cause riverine flood-related damage to buildings and expose vulnerable segments of the population to physical injuries, respiratory, water-borne and food-borne illnesses, and mental health impacts.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
Community	High Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Could result in increased exposure to illness and pathogens (water-borne, molds, etc.). • Contaminated private wells and compromised septic systems were a problem in the 2017 and 2019 Ottawa River floods. • For those who are most impacted by flooding, the physical and mental health effects can be severe. Often dwellings become uninhabitable due to the risk of fire and mold. Lower income individuals may not have insurance and will often not be able to find alternative accommodations or replace their belongings. These households usually also lack access to mental health supports as these are very expensive. This puts their long-term health into peril and signals that the trauma of the situation could be long-lasting and severe. The risk of illness requires evacuation and relocation, both of which are major challenges. • Low income tenants can find themselves being moved out of units that are no longer habitable due to flooding or mould from water infiltration. This could burden an already stressed social housing waitlist. • Previous flooding events have required re-deployment of many departmental staff in the emergency response (affects many departments including Public Works, Ottawa Public Health, etc). • City resources to support communities is significant, however localized in impacted areas. Limited critical infrastructure is located within floodplains. Communities can be highly impacted for prolonged periods where precipitation occurs during spring freshet. • 2019 Ottawa River flooding resulted in City staff being redeployed for 2 months (and budgetary costs of $2 Million) • The impacts from flooding can cause severe strain on housing vulnerable populations if Social Housing stock is deemed inhabitable, and repair costs can be a burden. • Community concerns about ability to cope (10-15% of those impacted seek City support measures such as emergency shelter after an event) • Decrease in property value for homes in flood plains. • Risks for Rideau River and other smaller tributaries are less known than for the Ottawa River flooding due to less robust flood forecasting, lack of historical floods, and less time to prepare given the nature of the watershed (flood occurs more quickly in response to heavy rains).	• Spring Freshet Task Force mobilized every year • The City and Ottawa Public Health have education, awareness and response plans to reduce injuries, illness and death from flooding • The City provides bottled water and set up onsite water distribution stations for residents with contaminated private wells • The new Official Plan will require developers to evaluate and mitigate risks to any proposed development within a 1:350 flood return event (for development subject to Site Plan Control). • Interactive flood mapping of various flood events is available on the City's website.

10. An increase in the volume and intensity of precipitation may overwhelm sewer systems and cause flood-related damage to buildings and expose vulnerable segments of the population to physical injuries, respiratory, water-borne and food-borne illnesses, and mental health impacts (non-riverine flooding).

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
Community	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Historical flooding resulted in damage to buildings, mold exposure, and exposure to septic waste. • The impacts from flooding can cause severe strain on housing vulnerable populations if Social Housing stock is deemed inhabitable. The repair cost after floods can also impact capital/operational budgets thereby placing more financial strain on our Social Housing Provider. • For those who are most impacted by flooding, the physical and mental health effects can be severe. Often, dwellings become uninhabitable due to the risk of fire and mold. Lower income individuals may not have insurance and will often not be able to find alternative accommodations or replace their belongings. These households usually also lack access to mental health supports as these are very expensive. This puts their long-term health into peril and signals that the trauma of the situation could be long-lasting and severe. The risk of illness requires evacuation and relocation, both of which are major challenges. • Low income tenants can find themselves being moved out of units that are no longer habitable due to flooding, mould from water infiltration, other issues from intense water weather related impact. This would burden an already stressed social housing waitlist and the economic impact would be felt across the sector. Senior residence homes may be impacted more greatly from a health and economic perspective.	• The City has emergency plans that can be implemented to provide temporary relief to residents affected by flooding, ensuring that they have a safe place to go, as well as provide food, clothing and other essential needs. While these temporary services are essential, adding supports for mental health and longer-term transitional supports will be necessary. • Continue to participate in the Human Needs Taskforce as needed to ensure that social supports are in place for those in need. • As part of the Wet Weather Infrastructure Management Plan, the City has completed community flood risk profiles to identify areas at risk under heavy rainfall and prioritize neighborhoods for proactive measures to reduce flood risks. • Residential Protective Plumbing Program that supports homeowners to install backflow prevention valves and sump pumps to protect their homes from flooding. • The Backflow Prevention Program helps prevent the backflow of contaminated water from buildings connected to the City's drinking water system.

11. An increase in multi-day ice storm events may cause damage to power infrastructure resulting in more frequent and prolonged power interruptions / blackouts and may result in extreme cold-related illnesses / exposure and hazards.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• City risk is low since a lot of City buildings have backup generators and there are processes in place to address heating during power outages in municipal buildings. • Consequences depend on the extent of the community impacted. Large events, like ice storms, can have effects that are long lasting, especially for lower income individuals who have limited resources to adapt (e.g., inability to purchase enough food to have on hand in case of store closures, unable to afford mitigation technologies like generators, unable to access warming centres due to distance and lack of transportation). • While people may be reluctant to leave homes and pets and get cold-related illnesses / exposures, it's more probable that people react to carbon monoxide poisoning and fire related injuries • People may be able to be resilient to one event, but the risk level will likely increase over the season / period events occur more frequently.	• The Emergency Operations Centre is activated when there is a large power outage or blackout. • Emergency preparedness information is promoted to residents (e.g. 72-hour kits; Ontario Electricity Support Program, etc.). • Power lines are being upgraded.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Impact on social housing residents and the financial impact on mechanical heating equipment costs. • Closures caused by power outages may disproportionately affect those without homes, who often rely in Libraries as warm refuges. • Retirement residents without requirements for backup generators.	

12. An increase in the frequency and intensity of extreme weather events may negatively impact the delivery of essential services (e.g., power supply, food banks, mental health supports, etc.).

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
Community	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Response is dependent upon the scale of the area and number of residents affected by the outage, the demographics of the affected population (e.g., mental and physical health disabilities) and if they have back-up generators for power. • Increased demand to access resources that relieve daily costs (e.g., reduced bus fare, subsidies for food programs). • Economically challenged families could be pushed to poverty resulting in an increased need for social assistance. • Increased costs may result in a scaling back of community outreach visits or in-person programming to at-risk communities. • Ongoing lack of supports, especially for mental health and complex cases, can be exacerbated by increased demand (social systems are the vulnerability) • Some populations have a strained relationship with the City, Province and local authorities (e.g., Indigenous and Black communities). This distrust may increase the vulnerability of these populations. • Not for profits are not equipped to deal with an increase in demand for emergency or social services.	• Emergency preparedness information to residences (e.g. 72-hour kits; Ontario Electricity Support Program, etc.) • The Community Paramedicine Program is in place to improve the resiliency of seniors and vulnerable populations who are living at home, reducing impact upon emergency paramedic services. • Under the Extreme Heat, Cold and Smog Plan for the City of Ottawa, Ottawa Public Health (OPH) staff assist service providers to develop resiliency plans for extreme weather events including storms and extreme heat and cold. The plan ensures integration of prevention, mitigation and preparedness via risk monitoring and early warning to inform local service providers and partners in health and emergency management to guide their actions as an early intervention. • The City and OPH have established environmental health education, awareness and response plans to reduce climate related illnesses and deaths associated with extreme heat and humidity, cold weather, poor air quality (including wildfire smoke) and flooding. • Providing parents with tools / resources to use if there is social isolation. • Continue to update continuity of Operations Plans, Emergency Management Plan and evacuation plans.

13. Global climate change may cause supply chain instability and/or market failures impacting availability and the cost of goods and services, including food, resulting in increased pressure those people experiencing poverty, those in precarious economic situations and community services.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.
Community	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Already seeing the impact in Social Housing capital projects. Some major capital repairs are delayed and have a substantial impact on the habitability of homes for low income residents. • Increased costs may result in a scaling back of community outreach visits or in-person programming to at-risk communities. • Immigrants are particularly at risk for food insecurity and trying to get culturally appropriate food. • More vulnerable families have been pushed to poverty resulting in their need for social assistance. • Increased demand for social assistance (and associated costs). • Stockpiling has limitations due to expiration dates and storage costs. • Increased food costs but provincial funds have not matched. • Increased pressure on subsidized housing (pay rent vs food / nutrition). This has placed a need for additional funding to support families and partnering agencies. • Support for self-employed clients (pop-up businesses to respond to food shortage, etc.) will increase. • Access to personal protective equipment has been an issue with COVID-19 resulting in access issues (e.g. City dental clinics and emergency services).	• Promote emergency preparedness information to residences (e.g. 72-hour kits; Ontario Electricity Support Program, etc.) • Review operation continuity plans and PPE stockpiling procedures / plans (e.g. review materials what materials the City should maintain during an emergency – fuels, personal protective equipment, vaccines, pool test kit, etc.) • Coordinate with partners who provide services to priority populations and the social supports for back up plans.

D.4 Drinking Water

The drinking water focus area covers climate impacts to water purification and distribution, including communal wells, as well as private wells. The risks are derived from separate Climate Vulnerability and Risk Assessments (CVRAs) that were completed on City owned infrastructure by City staff and their consultants using the PIEVC methodology. This includes CVRAs for the two Water Purification Plants as well as the water distribution system. Because of the nature of the PIEVC process, non-City owned assets and the impacts on the community are considered as part of the assessment of City services and there may not be separate risk ratings for the Community for some Impact Statements. Furthermore, as the PIEVC assessment focused on asset components of the water system, where possible, the impacts were rolled up to a systems level to align with the city-wide CVRA methodology. Further information can be found in the CVRA for Water Services and in the 2023 Water Purification Plants Comprehensive Development Plan.

The following tables include a summary of the Focus Area noted impacts, noted vulnerabilities and possible consequences. Following this table are the impact statements used in the CVRA along with specific vulnerability / consequence notes and ratings at the City and community scale.

Table D.4 Summary of Focus Area Impacts, Vulnerabilities and Consequences by Climate Hazard Theme

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Extreme Heat, Drought and Humidity 	• Reduced pressure from increased outdoor water demand • Reduced aquifer recharge / increased occurrence of dry shallow wells • Electrical and communication systems can malfunction in extreme heat • Increased risk of wildfires can increase treatment demands and cause taste/ odor issues from nutrients, particulate or contaminants	• Private landowners with shallow wells (9% of Ottawa is on private wells) • Past droughts (e.g., 2012) required trucked water and deeper wells • Communal wells are less equipped than water purification plants to treat nutrients, particulate or contaminants from wildfires (fire chemicals/foam can persist for years) • Electrical and communication systems can malfunction at pump stations, water purification plants or communal wells.	• Reduced level of service (reduced pressure in water distribution) or no service (no electricity) • Increased costs if water delivery is required to privately serviced areas • Demand for more reliable water supply for areas on private wells • Increased costs for increased water treatment (from wildfires)

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Seasonal Variability 	• Damaged / compromised water distribution and treatment systems (from freeze-thaw or frazil ice) • Reduced water quality in shallow wells (from increased salt application)	• Increased settlement, heave, and misalignment of surface or shallow potable water conveyance infrastructure (from freeze-thaw) • Increased frazil ice (collection of ice crystals in flowing water) can affect water purification plants • Shallow private wells are vulnerable to contamination from road salt • Cumberland and Fitzroy residents who get their water from a “sand pipe” directly from the Ottawa River (changes to water quality will have a direct impact). • Potential illness related to shallow well water contamination and need for well water disinfection systems to prevent waterborne illnesses.	• Water main breaks, reduced level of service and increased repairs and renewals. • Damage to water purification plants intake systems, reduced functionality and increased repair / renewal. • Costs to develop deeper source of drinking water (private wells)
Precipitation Volume and Intensity 	• Damaged / compromised water systems from riverine or inland flooding • Compromised private wells • Reduced access to critical infrastructure (water purification plants)	• Riverine flooding has reduced access to the Britannia Water Purification Plant. Both water purification plants have detailed response plans based on river levels for up to a 1:500 year river level and long-term solutions are being identified • Localized flooding from heavy rains can impact operations at both plants • Erosion can damage trunk watermains at watercourse crossings • Pump stations located in the floodplain • Private wells contaminated with flood waters/ septic waste putting shallow aquifers and some drinking water wells at risk.	• Reduced level of service • Increased capital and repair costs • Possible water-borne illnesses in the community from private well water contamination. • Contamination of rural wells due to poor soil drainage issues.
Extreme Events 	• Damaged / compromised drinking water distribution or treatment systems • Electricity or communication interruptions / blackouts	• Electricity outages affect drinking water pump stations, communal wells, elevated storage tanks	• Reduced level of service or loss of service • Increased capital and repair costs

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Global Climate Change 	• Increased material costs • Delayed projects	• Exposure to increased costs, delayed material shipments, unavailability of critical parts for fleet or infrastructure etc.	• Direct impact to the cost of construction materials and activities. • Delayed capital projects resulting in reduced level of service • Higher infrastructure project costs are ultimately borne by the community through higher property taxes and water/sewer rates

The following table presents a summary of the Drinking Water Focus Area Impact Statements. Details on the ratings for each Impact Statements follows below.

	Impact Statement	City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
1.	Hotter and drier summers could result in reduced pressure in water distribution systems due to increased outdoor water demand.	Low Vulnerability	Low Risk	Low Risk	Low Risk	Low Risk	Continue to manage through existing controls and procedures						
2.	Hotter and drier summers may result in reduced aquifer recharge, which increase the occurrence of dry wells on private lands.	Low Vulnerability	Low Risk	Low Risk	Low Risk	Low Risk	Continue to manage through existing controls and procedures	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
3.	Hotter and drier summers may increase the likelihood of wildfires resulting in a release of nutrients and particulate into source waters and cause increased treatment demands and taste/ odour issues.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.						
4.	An increase in seasonal winter freeze thaw events may increase road salt use and result in reduced riverine and shallow well water quality.	Low Vulnerability	Low Risk	Low Risk	Low Risk	Low Risk	Continue to manage through existing controls and procedures.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Impact Statement		City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
5.	More frequent winter freeze thaw cycles could lead to increased settlement, heave, and misalignment of potable water conveyance infrastructure resulting in water main breaks, reduced level of service and increased repairs and renewals.	Low Vulnerability	Medium-High Risk	Medium-High Risk	Medium-High Risk	Medium-High Risk	Identify possible controls and continue to review for change.						
6.	Changes in seasonal temperatures may result in the development of frazil ice and result in damage to the water treatment plants intake systems, reduced functionality and increased repair / renewal.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.						
7.	Cold extremes may lead to a reduced level of service and decreased pressure in the distribution systems as a result of structural damage and misaligned pipes.	Low Vulnerability	Medium Risk	Medium Risk	Medium Risk	Low Risk	Identify possible controls and continue to review for change.						
8.	More severe riverine flooding can damage trunk watermains at watercourse crossings or pump stations in the floodplain.	Medium Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	Medium-High Risk	Develop a plan to address risk.						
9.	More severe riverine flooding can reduce access to the Britannia Water Treatment Plant and impact operations at both plants resulting in a reduced level of service and more frequent repairs and renewals.	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.						
10.	More intense precipitation may result in localized flooding at the Water Treatment Plant resulting in	Low Vulnerability	Low Risk	Low Risk	Low Risk	Low Risk	Continue to manage through existing						

Impact Statement		City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
	reduced level of service, and more frequent repairs and renewals.						controls and procedures						
11.	More intense precipitation may damage private wells, causing increased repairs and renewals and reduced water quality in watercourses or aquifers.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
12.	An increase in multi-day ice storm events or extreme weather may result in power outages that can affect pump stations and reduce overall performance, shorten lifespan and increase maintenance activity.	Low Vulnerability	Low Risk	Low Risk	Low Risk	Medium Risk	Continue to manage through existing controls and procedures.						

1. **Hotter and drier summers could result in reduced pressure in water distribution systems due to increased outdoor water demand.**

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Low Vulnerability	Low Risk	Low Risk	Low Risk	Low Risk	Continue to manage through existing controls and procedures.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Impact of drought on the water system is expected to be low.	• The water treatment and distribution system has been designed to account for increased demand and lower pressure scenarios. • Impact of a drought scenario on water distribution is being tested as part of the renewal of the Infrastructure Master Plan

2. **Hotter and drier summers may result in reduced aquifer recharge, which increase the occurrence of dry wells on private lands.**

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Low Vulnerability	Low Risk	Low Risk	Low Risk	Low Risk	Continue to manage through existing controls and procedures.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• The City is comprised of 90% water distribution system, 9% private wells and 1% municipal wells. • Shallow wells are vulnerable to hot and dry weather; however very few private owners have shallow wells within the City. • Could result in reduced aquifer recharge and/or increased occurrence of dry shallow wells. E.g., South Nation's watershed is 70% rural and in the 2012 drought water had to be trucked in and many private wells were dug deeper. Mississippi watershed has experienced four droughts since 2012. • If water shortages in private wells become a frequent occurrence, the City could be called upon to provide more reliable infrastructure to those on private wells. • Irrigation sources could be impacted resulting in health and safety issues.	• Deeper private wells.

3. Hotter and drier summers may increase the likelihood of wildfires resulting in a release of nutrients and particulate into source waters and cause increased treatment demands and taste/ odour issues.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• The risk to raw water supply is related to increases in both particulate and dissolved organic matter (DOC) following the destabilization of the landscape in the locality of the fire. However, the treatment plants are capable of handling moderate particulate / DOC loadings associated with wildfires with some proactive changes to plant operations. Taste/odour might pose a challenge. • For the communal well systems, a local forest fire could lead to a release of natural organic matter (NOM) in the recharge zones for the wells. If firefighting foams are used to address the fire in these areas, it could lead to contamination of the aquifers. Most of the communal wells are not equipped to respond to increased NOM or chemical contamination from wide use of firefighting foams (Carp and Vars could manage some impacts, with their existing GAC facilities). • Fire would require increased water treatment resulting in increased costs to the City / private landowners. • Electrical and communication systems can malfunction and be damaged by wildfires.	• The City is evaluating the effectiveness of PAC (powdered activated carbon) that could be a standby system installed at both of treatment plants which would allow for a treatment capability for short-term events such as natural "earthy" taste episodes, upstream chemical spills, or wildfires.

4. An increase in seasonal winter freeze thaw events may increase road salt use and result in reduced riverine and shallow well water quality.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability	Low Risk	Low Risk	Low Risk	Low Risk	Continue to manage through existing controls and procedures.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Based on past groundwater studies, shallow wells i.e. dug wells are more vulnerable to high chloride. High chloride level will impact aesthetics and taste. Costs to dig deeper private wells. • The City's municipal wells are not currently impacted by road salt, this is assessed annually as part of the annual source protection reporting, where the chloride level in municipal wells is reviewed. Road salt was assessed as part of the source protection assessment report as a potential significant drinking water threat (SDWT), which completed calculations based on the percentage of impermeable surface within the wellhead capture zones (as per Ministry of Environment, Conservation and Parks (MECP) methodology). Road salt was not considered a SDWT based on the calculations at the City's municipal well;	• The City and conservation authorities mitigate risks to well head protection areas through the Source Protection Plans. • The City has a salt management plan, aiming to reduce salt use over the long term.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
however the calculation methodology is being amended and will need be re-assessed in the future. • More freezing rain means more salt and thus more areas to store it. Storage of salt needs to be done appropriately to not contaminate wells. • The City does have a salt management program, but it does not apply to private property. Large private parking lots and cumulative impacts of residential use are big factors that need to be addressed.	

5. More frequent winter freeze thaw cycles could lead to increased settlement, heave, and misalignment of potable water conveyance infrastructure resulting in water main breaks, reduced level of service and increased repairs and renewals.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability	Medium-High Risk	Medium-High Risk	Medium-High Risk	Medium-High Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Increased settlement, heave, and misalignment of shallow potable water conveyance infrastructure. This can result in water main breaks, reduced level of service and increased repairs and renewals. • Small equipment, susceptible to freezing, but underground.	• The City is reviewing impacts on feedermains as part of the update of the Drinking Water Master Plan (part of the Infrastructure Master Plan).

6. Changes in seasonal temperatures may result in the development of frazil ice and result in damage to the water treatment plants intake systems, reduced functionality and increased repair / renewal.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Increased frazil ice can damage the intake systems of water purification plants, causing reduced functionality and increased repair / renewal. • This is a concern for the Lemieux Water Purification Plant (WPP) as the intake pipe at Britannia WPP is sufficiently deep.	• The City is undergoing a project to relocate the primary intake for the Lemieux Island Water Purification Plant (WPP) within the Ottawa River due to issues related to frazil ice buildup at the existing intake; the new intake will be located deeper within the Ottawa River.

7. Cold extremes may lead to a reduced level of service and decreased pressure in the distribution systems as a result of structural damage and misaligned pipes.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability	Medium Risk	Medium Risk	Medium Risk	Low Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• In addition to pipe breaks, cold extremes can result in power outages. The vulnerability is dependent on exposure of external power supply transmission system / increased severity related to larger service area. • Power outages affect pump stations, communal wells, elevated storage tanks • Small equipment may be susceptible to freezing.	• The 2023 Water Master Plan will explore the system's level of service impacts due to watermain breaks resulting from freezing.

8. More severe riverine flooding can damage trunk watermains at watercourse crossings or pump stations in the floodplain.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	Medium-High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Damage at trunk watercourse crossings resulting from riverbed erosion. This can result in reduced potable water delivery; reduced water pressure; increased replacement/repair costs • Vulnerability dependent on integrity/design of erosion mitigation measures related to levels of service should trunk be damaged. • Requires further riverine hazard analysis for assets in floodplains.	• Monitoring

9. More severe riverine flooding can reduce access to the Britannia Water Treatment Plant and impact operations at both plants resulting in a reduced level of service and more frequent repairs and renewals.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Riverine flooding caused reduced access to the Britannia Water Purification Plant in 2019. • Lemieux and Britannia plants are at risk of damage during severe flooding	• Both Water Purification Plants have detailed flood response plans for up to a 1:500 year river level, using temporary protective barriers. • Long-term flooding solutions have been conceptualized for both plants as part of the 2022 Comprehensive Development Plans.

10. More intense precipitation may result in localized flooding at the Water Purification Plants resulting in reduced level of service, and more frequent repairs and renewals.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability	Low Risk	Low Risk	Low Risk	Low Risk	Continue to manage through existing controls and procedures.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Localized flooding from heavy rains can impact operations at both plants. • Erosion can damage trunk watermains at watercourse crossing and impact service levels.	• Both Water Purification Plants have response plans for localized flooding from heavy rains.

11. More intense precipitation may damage private wells, causing increased repairs and renewals and reduced water quality in watercourses or aquifers.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Prior flooding events have contaminated private wells with poor drainage.	• The City trucked in water in the past.

12. An increase in multi-day ice storm events or extreme weather may result in power outages that can affect pump stations and reduce overall performance, shorten lifespan and increase maintenance.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability	Low Risk	Low Risk	Low Risk	Medium Risk	Continue to manage through existing controls and procedures.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Power outages affect pump stations, communal wells, elevated storage tanks • Small equipment may be susceptible to the impacts of freezing rain.	• Most pump stations have back-up power. For pump stations without backup power, operation staff will bring portable generator on-site. • Additional back-up power is proposed for the Water Purification Plants as part of the Comprehensive Development Plans

D.5 Economy

The Economy Focus Area examined impacts and opportunities to businesses and economic development from a changing climate. Changing weather parameters and the disruptions that result from extreme weather events (e.g., utility supply interruption, supply chain disruption, emergency management, etc.) could have a major impact on business continuity, tourism and economic development in general.

The following tables include a summary of the noted impacts, vulnerabilities and possible consequences to the Focus Area. Following this table are the impact statements used in the Climate Vulnerability and Risk Assessment (CVRA) along with specific vulnerability / consequence notes and ratings at the City and community scale.

Table D.5 Summary of Focus Area Impacts, Vulnerabilities and Consequences by Climate Hazard Theme

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Extreme Heat, Drought and Humidity 	• Increased health and safety risks to workers • Reduced or shifting economic development opportunities • Reduced water quality (algal blooms)	• Businesses that rely on summer outdoor recreation and tourism (reduced people outside / using services due to heat) • Outdoor events and venues could be cancelled or at the extreme, become unviable (e.g. Ottawa Race Weekend, Cycling Tour, festivals and fairs) during extreme heat events • Businesses and City services that operate outdoors (landscape, construction, waste collection etc.) could see reduced productivity and/or working hours, increased breaks or changes to work conditions • Businesses, organizations or institutions operating in buildings without air conditioning can lead to reduced productivity and/or working hours • Businesses that depend on waterways (e.g. river or canal tours) may be adversely affected by algal blooms and increased weed growth • Businesses requiring fire suppression water storage permits (e.g. Lee Valley Ltd. warehouse, etc.)	• Increased costs to upgrade buildings for greater climatic resiliency (e.g. insulation, greater energy costs to cool buildings, greater insurance costs, etc.). • Adjusted work schedules for outdoor workers/ lost productivity to meet health and safety regulations • Canceled or rescheduled City or community programming or services • Changes to or increased tourism pressures due to a more compressed season • Reduced walkability and water recreation in portions of the summer with extreme heat • Costs to retrofit buildings • Increased climate control expenses (A/C)
Seasonal Variability 	• Reduced business operations and economic development opportunities due to declining winter	• Winter tourism (e.g., Winterlude, Rideau Canal Skateway) • Seasonal agritourism	• Reduced revenue from decline of winter tourism or seasonal agritourism. • Reduced tax revenues from a decline in businesses in the area

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Precipitation Volume and Intensity 	• Reduced business operations and economic development opportunities	• Businesses along the Ottawa and Rideau Rivers • Businesses affected by inter-provincial bridge closures (Chaudière bridge closed in 2019)	• Investment / business loss (as well as lost opportunity) • Reduced tourism • Reduced availability / increased cost of insurance for businesses in vulnerable locations • Loss of inventories due to water damage.
Extreme Events 	• Direct damage to businesses and associated financial losses • Disrupted business continuity	• Brick and mortar based businesses are more exposed to extended closures and a loss of revenue (vs. online businesses)	• Investment / business loss (as well as lost opportunity) • Loss of utility service (including telecommunications, electricity, gas service) to businesses due to damage • Tourism losses due to damaged infrastructure
Global Climate Change 	• Reduced business operations and economic development opportunities • Increased migration to Ottawa (climate refugees / immigrants)	• Product-based businesses most likely to be impacted (since can't easily shift to online) • Development and construction sectors	• Development impacts (less construction starts – this could lead to an increase in the cost of housing) • Investment / business loss (as well as lost opportunity) • Closure of local businesses • Support systems would be placed under greater pressure with increased migration

The following table presents a summary of the Economy Focus Area Impact Statements. Details on the ratings for each Impact Statements follows below.

	Impact Statement	City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
1.	Extreme heat could result in inconsistent tourism in summer and shoulder seasons.	Low Vulnerability						Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
2.	Unusually hot temperatures and/or high humidex periods may restrict outside work (e.g., construction, landscaping, agriculture) negatively impacting business operations and economic development.	Low Vulnerability						Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
3.	Hotter summers may lead to Reduced water quality at beaches and natural outdoor swimming areas (e.g., algal blooms) resulting in conditions that are not favorable to use and reduced recreation and tourism.	Low Vulnerability						Medium Vulnerability	Medium Risk	Medium Risk	High Risk	High Risk	Develop a plan to address risk.
4.	Hotter summers and longer spring and fall seasons may result in increased migration and tourism to the City and place strain on land affordability including housing.	Low Vulnerability						Low Vulnerability					
5.	Warmer, shorter winters and seasonal variability may lead to decline of winter tourism and recreation, some seasonal agri-tourism, and economic welfare.	Medium Vulnerability	Low Risk	Medium Risk	Medium Risk	Medium -High Risk	Identify possible controls and continue to review for change.	High Vulnerability	Low Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required.

Impact Statement		City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
6.	An increase in extreme weather events (flooding, tornadoes, winter storms) may disrupt business continuity, result in extended closures and have a wide range of financial impacts in the community.	Medium Vulnerability	Medium-High Risk	Medium-High Risk	Medium-High Risk	Medium-High Risk	Develop a plan to address risk.	High Vulnerability	High Risk	High Risk	High Risk	High Risk	Immediate action required.
7.	Extreme weather events could lead to increased demand for weather protection or remediation services, or technical innovation, creating economic development opportunities.	Low Vulnerability						Low Vulnerability					
8.	Global climate change may cause supply chain instability and/or market failures impacting the availability of fuels and other goods required to provide critical services to the community.	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.
9.	Global climate change may increase migration to Ottawa as other regions become less inhabitable creating opportunities for economic development.	Low Vulnerability						Low Vulnerability					

1. Extreme heat could result in inconsistent tourism in summer and shoulder seasons.

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Low Vulnerability					
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• City will likely have to invest more in cooling centres, splash pads, and other public health programs to address health impacts. • There is an increased interest in water access. Cost of cooling municipal facilities would rise (libraries, community centres, etc.) • Warmer summers may not have a positive effect on tourism, as extreme temperatures have negatively impacted visitor experience (e.g.: Canada Day 2018 saw 6,000 visitors on Parliament Hill instead of the estimated average 25,000 due to soaring temperatures and the Ottawa Race Weekend has dealt with extreme temperatures, elevating the risk of heat related illnesses). Visitors may choose alternative destinations with less extreme temperatures. • There is a push to encourage visitation on shoulder seasons and during winter, which would in part help businesses increase revenues during quieter times. Less of a winter tourism season will make this more challenging. • Some seasonal businesses may be able to stay open longer (e.g., patios, outdoor attractions, biking / walking / etc.) • A shorter winter season may negatively affect those attractions that rely on winter weather to operate (ex: Winter festivals, skating and skiing experiences, etc.) • Business and Community may need to retrofit/new facilities to adapt the changes in temperature. Changes in season may also mean competing for seasonal labor. • Outdoor festivals / event venues that do not have shaded areas or trees (ex: Wesley Clover Parks, LeBreton Flats, Lansdowne)	• Adjusting timing of outdoor recreation and sports programs.

2. Unusually hot temperatures and/or high humidex periods may restrict outside work (e.g., construction, landscaping, agriculture) negatively impacting business operations and economic development.

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Low Vulnerability					
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Businesses and City services that operate outdoors (landscape, construction, waste collection etc.) could see reduced productivity and/or working hours, increased breaks or changes to work conditions). • High impact to local projects if construction projects are delayed (higher costs plus inconvenience to community).	• None noted.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Maintenance and construction costs for facilities (buildings, parks and right of way properties) would rise. • Migrant workers may not have access to adequate shade structures and may be incented to work through breaks. • Reduction in days/hours available to be worked will result in reduced revenues. Recruiting labour for outdoor work may become even more difficult. • This will impact how people work which will impact local business and transportation/ transit services. • The changes in humidex will have air quality impacts for the community.	

3. Hotter summers may lead to reduced water quality at beaches and natural outdoor swimming areas (e.g., algal blooms) resulting in conditions that are not favorable to use and reduced recreation and tourism.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Medium Vulnerability	Medium Risk	Medium Risk	High Risk	High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Reduced use of beach operations and associated parks (Britannia, Mooney's Bay, Petrie Island, etc.) may reduce viability of tourism operations catering to these areas. Tax revenues may be negatively impacted by loss of business. • Businesses that depend on waterways (Rideau River tours, Rideau Canal boat cruises, etc.) may be adversely affected by algae blooms and increased weed growth. • May be a risk of over tourism due to a more compressed season. This could also place a greater strain on the built environment.	• None noted.

4. Hotter summers and longer spring and fall seasons may result in increased migration and tourism to the City and place strain on land affordability including housing.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Increasing land price for farmland and rural lands (suitable for uses beyond residential); increased pressure on natural areas; increased affordability issues. • Summer season may increase the number of investors visiting the City; heat waves and other extreme weather may also dissuade them. • Extreme weather events like tornadoes and strong storms could also impact visitor experience and outdoor events in Ottawa. Ottawa's robust festival and events scene could be impacted as many are outdoors, therefore impacting the ability to attract and host these key economic drivers (ex: Canadian Tulip Festival, Ottawa Race Weekend, Capital Pride, Bluesfest, Sporting events, etc).	• None noted.

5. Warmer, shorter winters and seasonal variability may lead to decline of winter tourism and recreation, some seasonal agri-tourism, and economic welfare.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Low Risk	Medium Risk	Medium Risk	Medium-High Risk	Identify possible controls and continue to review for change.
Community	High Vulnerability	Low Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Increased pressure to have more outdoor refrigerated rinks and less dependence on the canal. • Rideau Canal Skateway and Winterlude would be affected. In the case of shorter skating season on the Rideau Canal Skateway, there is a risk of over tourism and overcrowding. • Temperature increases have already affected Winterlude programming, forcing organizers to take a more urban approach to programming to ensure the festival can continue regardless of environmental factors. • These weather changes would also adversely affect winter offerings such as ski hills, winter trails, and more. • Markets may need to move indoors (in winter and summer), but there may not be enough space available. This could be an investment opportunity. • More frequent program/rental cancellations and loss of City revenue. Tax revenues from tourism operators' properties would be reduced if businesses become insolvent due to inevitability related to climatic conditions. Costs of operating some municipal facilities could rise due to energy required for cooling (hockey arenas, etc.). • There is a push to encourage visitation on shoulder seasons and during winter, which would in part help businesses increase revenues during quieter times. Less of a winter tourism season will make this more challenging. • The new Parks Master Plan calls for 36 new outdoor rinks by 2031 and possibly three new, additional outdoor refrigerated rinks. The redirection of funds to warm season amenities may impact this objective.	• Adjusting timing of outdoor recreation and sports programs.

6. An increase in extreme weather events (flooding, tornadoes, winter storms) may disrupt business continuity, result in extended closures and have a wide range of financial impacts in the community.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium-High Risk	Medium-High Risk	Medium-High Risk	Medium-High Risk	Develop a plan to address risk.
Community	High Vulnerability	High Risk	High Risk	High Risk	High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Extreme weather events like tornadoes and strong storms could impact visitor experience and outdoor events in Ottawa. Ottawa's robust festival and events scene could be impacted as many are outdoors, therefore impacting the ability to attract and host these key economic drivers (e.g., Canadian Tulip Festival, Ottawa Race Weekend, Capital Pride, Bluesfest, Sporting events, etc).	• Education to businesses on emergency preparedness.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Insurance premiums and repair costs could be substantial. Loss of business that results from inviable operations could also be substantial. Supply chains could also be adversely affected. • Logistic and distribution centres could be impacted by extreme weather (e.g., Amazon). • Businesses affected by inter-provincial bridge closures (Chaudière bridge closed in 2019). • Landlords need to be taking action to make sure that their properties are able to withstand the impacts of climate change. Many commercial tenants are powerless to do anything on their own. Unfortunately, landlords often don't act unless they are given a financial incentive or they are forced to act. • Investors might avoid Ottawa (even though impacts will be far reaching to all cities). • Most Economic Development plans /strategies are 3-5 year strategies; looking at something 10 years+ out is unfamiliar to most involved in the economic development plans.	

7. Extreme weather events could lead to increased demand for weather protection or remediation services, or technical innovation, creating economic development opportunities.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Not seen as a significant opportunity. • Traditionally a lot of vendors send their technology somewhere else as Ottawa does not procure locally. This creates a disincentive for local solutions. • As building technologies become increasingly more advanced, the trade community need to have very specialized construction trades persons. • With COVID-19 and work from home requirements, people are moving to the suburbs which could put the City's core at risk (in terms of renewal / revitalization)	• None noted.

8. Global climate change may cause supply chain instability and/or market failures impacting the availability of fuels and other goods required to provide critical services to the community.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.
Community	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place

• The City is already experiencing increased costs, timeframes and lack of resources for capital projects in 2021. Supply chain instability has an adverse impact on meeting program deadlines for capital repairs. It also has an impact on capital repair estimates and can cause financial strain to cover the cost overages. For example, the City is already seeing the impact in Social Housing capital projects. Some major capital repairs are not able to complete in the required timelines. These repairs have a substantial impact on the habitability of homes for low income residents. • Direct impact to the cost of construction materials (e.g., asphalt) and construction activities. • Increases inequity, as financially strained households are more affected. • May encourage electrification and renewable fuels.	• Coordinate with partners who provide services to priority populations.

9. Global climate change may increase migration to Ottawa as other regions become less inhabitable creating opportunities for economic development.

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Opportunities for economic growth from new skilled workers may be offset by increased demands for social services from climate refugees. • Immigration places demand on the need for affordable and accessible housing; migration has increased interest in other sectors (e.g., farming) but faces access barriers (e.g., current policies are not supportive of small-scale agriculture) • With COVID-19 and work from home requirements, people are moving to the suburbs which could put the City's downtown at risk (in terms of renewal / revitalization)	• None noted.

D.6 Emergency Management

The Emergency Management Focus Area examined the impacts of climate change on emergency prevention, mitigation, preparedness, response and recovery plans.

The following tables include a summary of the noted impacts, vulnerabilities and possible consequences for the Focus Area. Following this table are the impact statements used in the Climate Vulnerability and Risk Assessment (CVRA) along with specific vulnerability / consequence notes and ratings at the City and community scale.

Table D.6 Summary of Focus Area Impacts, Vulnerabilities and Consequences by Climate Hazard Theme

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Extreme Heat, Drought and Humidity 	• Increased severity of heat-related health and safety issues • Additional strain/ reduced capacity of emergency response and social support systems (e.g. paramedics) • Increased risk of wildfires and poor air quality	• Individuals with pre-existing physical and mental health conditions or who have mobility barriers, the very young and older adults, pregnant women. • Individuals that spend a significant amount of time outdoors, such as children, youth, athletes, and especially outdoor workers • Households with limited financial resources; individuals experiencing homelessness or who are precariously housed • Rural communities adjacent to areas at risk of wildfire with limited water for firefighting	• More heat- and smoke-related illnesses and fatalities, especially for disproportionately impacted populations • Increased demands on emergency response and social services • Overwhelming of hospitals and social services • Increased wildfire management requirements and costs • Increased demand for libraries, recreation facilities and community centers as places to cool, especially in at-risk neighborhoods
Seasonal Variability 	• Increased slips and falls from increased winter freeze-thaw	• Older adults and people with mobility challenges	• Increased claims to the City for slip and falls, resulting in higher payouts and higher insurance premiums.
Precipitation Volume and Intensity	• Increased demands on emergency response and social support systems • Isolation of residents / reduced access to communities	• Emergency services can be stretched as they respond to flood impacts, while maintaining continuity of operations with other calls for service and regular operations	• Increased pressure on emergency responders • Increased demand for / use of community services, like food banks • Increase in pressure on the City's building inspection unit

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
		• Communities in West Carleton including Fitzroy Harbour, Britannia, and Cumberland (~300 – 400 homes along Ottawa River affected in 2017 and 2019) • Communities along the Rideau River located within the flood plain (e.g. near Brewer, Brantwood, and Windsor parks, Vanier) • Lower income households are most impacted as they may not have insurance and may not be able to find alternative accommodations	• Financial hardship and displacement of populations • Physical and mental impacts to community members • Damage to underground infrastructure (telecom, gas etc.) and danger to residents if water reaches electrical panels in basements of homes (2019 flood event – had to shut off electricity to various dwellings) • Communications outages
Extreme Events 	• Increased demands on emergency response and social support systems • Electricity or communication interruptions / blackouts • Damaged / compromised critical infrastructure assets (water / wastewater, health) • Isolation of priority populations	• Increased stress on First responders • Increased pressures on social service agencies • Response during concurrent events (e.g. winter storm and electricity outage; flooding and electricity outage) • Persons without insurance, or inadequate insurance (ex: no flood coverage) • More remote rural populations who may be cut off from roads / utilities	• Increased demands on emergency response and social services (increased call volume) • Increased disruption to all City operations and business continuity (re-deployment of staff). • Overwhelming of hospitals and social services • Increased demand on emergency responders - staff health; staff shortages; Workplace Safety and Insurance Board (WSIB) • Increased claims to City for slip and falls, resulting in higher payouts and higher insurance premiums • Communications outages, such as during the 2019 Tornado event
Global Climate Change 	• Supply chain breakdowns (e.g., food, fuel, other goods) causing increased costs • Increased migration to Ottawa (climate refugees / immigrants)	• Populations that depend on community services (e.g. food banks, social assistance) • Additional households/ families may require social assistance • Lack of capacity in social systems, especially for mental health and complex cases	• Increased pressure on community services including social housing, food banks, mental health support services or subsidized transit • Emergency response to receive refugee populations that have been determined as a priority by the federal government

The following table presents a summary of the Emergency Management Focus Area Impact Statements. Details on the ratings for each Impact Statements follows below.

	Impact Statement	City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
1.	Heat waves and/or high humidex periods may increase the number and severity of heat-related health and safety issues, particularly for first responders, priority populations and those with existing health conditions.	Medium Vulnerability	Medium-High Risk	High Risk	High Risk	High Risk	Immediate action required.	Medium Vulnerability	Medium-High Risk	High Risk	High Risk	High Risk	Immediate action required.
2.	Hotter and drier summers may increase the likelihood of urban and rural wildfires resulting in harm and damage to forests and settlement areas and additional strain on forest management / wildfire suppression programs and resources.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
3.	Changing winter conditions may increase the number and severity of extreme cold-related health and safety issues (slips and falls, isolation, etc.) to vulnerable members of the population.	Medium Vulnerability	Medium-High Risk	Medium -High Risk	High Risk	High Risk	Develop a plan to address risk.	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Develop a plan to address risk.
4.	An increase in the volume and intensity of precipitation may increase riverine flooding and cause flood-related access issues to key roadways and damage to property and infrastructure throughout the community, leading to isolation of residents and/or challenges for emergency services.	Medium Vulnerability	Medium-High Risk	High Risk	High Risk	Very High Risk	Immediate action required.	High Vulnerability	Medium-High Risk	High Risk	High Risk	Very High Risk	Immediate action required.
5.	An increase in the volume and intensity of precipitation may overwhelm sewer systems and cause flood-related access issues to key roadways and damage to property and infrastructure throughout the community, leading to isolation of residents and/or challenges for emergency se rvices. (non-riverine flooding)	Medium Vulnerability	Medium Risk	Medium Risk	Medium -High Risk	High Risk	Develop a plan to address risk.	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.

	Impact Statement	City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
6.	An increase in the volume and intensity of precipitation may increase the demand for establishing emergency shelters and temporary housing as populations abandon their homes during floods.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.	Low Vulnerability					
7.	An increase in wind speeds and related extreme weather events, like tornadoes, may result in injuries, loss of life and damage to properties and infrastructure.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium -High Risk	Identify possible controls and continue to review for change.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium-High Risk	Identify possible controls and continue to review for change.
8.	An increase in multi-day ice storm events may result in damages to communication systems and electricity grids, impacting communication, transportation and emergency systems.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium -High Risk	Identify possible controls and continue to review for change.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium-High Risk	Identify possible controls and continue to review for change.
9.	An increase in the frequency, duration and intensity of extreme weather events may reduce the ability of the City, community service providers and social support systems to effectively provide services.	Medium Vulnerability	Medium Risk	Medium Risk	Medium -High Risk	High Risk	Develop a plan to address risk.	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.
10.	An increase in the frequency, duration and intensity of extreme weather events may increase personal stress such as anxiety, depression, violence, especially for individuals with pre-existing mental health issues.	Medium Vulnerability	Medium Risk	Medium Risk	Medium -High Risk	High Risk	Develop a plan to address risk.	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
11.	An increase in extreme weather events may increase the risk of damage to livestock and the need for the City to support the emergency disposal of deadstock.	Low Vulnerability						Low Vulnerability					

Impact Statement		City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
12.	Global climate change may cause supply chain instability and/or market failures impacting the availability and costs of goods and services which could impact emergency services.	Medium Vulnerability	Medium Risk	Medium Risk	Medium -High Risk	High Risk	Develop a plan to address risk.	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.

1. **Heat waves and/or high humidex periods may increase the number and severity of heat-related health and safety issues, particularly for first responders, priority populations and those with existing health conditions.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium-High Risk	High Risk	High Risk	High Risk	Immediate action required.
Community	Medium Vulnerability	Medium-High Risk	High Risk	High Risk	High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• More heat-related illnesses and fatalities, especially for disproportionately impacted populations such as very old and young, those who work outdoors, with pre-existing health conditions, those precariously housed and particularly those with poor access to air conditioning. • Increase in services required to support priority communities. Response activities, emergency cooling centres, etc. • Increased call volumes, morbidity / mortality, respiratory issues, strain on workforce (esp. those in personal protective equipment (PPE), Workplace Safety and Insurance Board (WSIB) claims, workplace absenteeism and longer offload delays. • Fire Services always has increased call volume during heat waves. These happen in the summer when staffing levels tend to be lower due to annual leave and overtime is increased. Fire Service members have risks associated with responding in their personal protective equipment causing heat related illnesses on scene; especially at fires when they are also working hard. • Not all city facilities have backup power or A/C which may be a challenge to selecting appropriate cooling centres in affected areas (e.g., schools, churches and many daycares do not have A/C or have inadequate A/C).	• The Extreme Temperature Places of Refuge Program allows for library facilities to be used as locations of refuge, heating or cooling centres during extreme temperature events. • The City is exploring ways to supplement resources with an “all-hazard” Urban Search and Rescue (USAR) type response team that can be deployed locally to assist in extreme weather events. • The City has an Emergency Communications Tactical Roll Out Plan which is used to inform and engage the community with timely, relevant and accurate information about City emergency response activities. • The Paramedic Pandemic Response Plan provides the City with the capability to respond to mass casualty incidents and provide emergency medical services to responders and those impacted by the incident. • The Community Paramedicine Program is in place to improve the resiliency of seniors and vulnerable populations who are living at home, reducing impact upon emergency paramedic services. • Firefighter training and modification of procedures to reduce heat related impacts • Guidance from Ottawa Public Health on working in extreme heat is shared with staff and appropriate breaks changes to work is provided as required. • Paramedic Service altered the uniform policy, provided staff with cool max t-shirts, cooling towels, cooling head wear. • The City maintains an $100,000,000 line of credit and annual budget of "One Time and Unforeseen Provision" for times of crisis

2. **Hotter and drier summers may increase the likelihood of urban and rural wildfires resulting in harm and damage to forests and settlement areas and additional strain on forest management / wildfire suppression programs and resources.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Vulnerability & Risk Ratings						
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Fires require a large response and is a drain on resources. • Constance Bay is particularly vulnerable (one main access into the village) • Urban areas are protected by full time fire staff with good access to hydrants. Rural areas are covered by volunteer firefighters and the issue is lack of hydrants but they have several systems in place to bring water to more rural areas (water is the key limiting factor). • There are natural areas that are close to residences / industry that are a risk for wildfires e.g., small grass fire in 2012 (Moodie bush fire); main issue was smoke. • Ottawa has a significant Wildland Urban interface. Resources required to mitigate a wildland fire in the City is significant. • Ottawa has been a host community for Northern Ontario evacuees (e.g. wildfires, floods, water contamination). Services provided include providing temporary lodging, food and hydration, transportation, recreational programming, and childcare. Financial costs are compensated by the federal government for host communities. • Impact to paramedic service is low (higher demand on fire services), but in 10-15 years could become high if becomes a more common occurrence.	• The City will conduct a Wildland Fire Risk Assessment to look at forests that have a higher potential to burn • Personal protective Equipment were purchased for Wildland firefighting. • All Urban pumps are now equipped with a 'Forestry Pack' for initial fire attack of brush or wildland fires • The City became a facilitator for resources that the responding agency requires, for example heavy machinery, building inspectors, engineers, food and hydration. • The Fire Department is increasing response capabilities by supplementing resources with an “all-hazard” Urban Search and Rescue (USAR) type response team • The City has an Emergency Communications Tactical Roll Out Plan which is used to inform and engage the community with timely, relevant and accurate information about City emergency response activities. • The City has an Emergency Social Services Plan that describes the planning and coordination of an evacuation or sheltering-in-place of people impacted by an emergency. • The City has a Municipal Emergency Plan in place to better respond to the needs of the community during a major emergency, while still ensuring the delivery of city services to the other areas of the City. • The City maintains an $100,000,000 line of credit and annual budget of "One Time and Unforeseen Provision" for times of crisis.

3. Changing winter conditions may increase the number and severity of extreme cold-related health and safety issues (slips and falls, isolation, etc.) to vulnerable members of the population.

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Develop a plan to address risk.
Community	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Increased demand on first responders and disruption to operations (increased call volume) and business continuity. • The City mobilizes centres as required, including the Emergency Operations Centre, emergency reception and lodging centres, warming centres and community support centres.	• Ottawa Public Health (OPH) has an Extreme Heat, Cold and Smog Plan for the City of Ottawa that is reviewed and updated every year by the Extreme Heat, Cold and Smog Planning Committee. It describes OPH and City responsibilities during a frostbite advisory or warning. It also includes the work our partners do to help residents cope with the cold.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Rural communities would be very affected by freezing rain since dependent on vehicles. • While many people are unaffected by such issues, isolation, slips and falls are often significant concerns for older adults, people with disabilities, parents of very young children and low income individuals. Many disabled individuals find themselves homebound for multiple days per month each winter as they wait for snow and ice clearing to make sidewalks safe and passable. This reduces their ability to access essential services (food shopping, appointments, social engagement). • Additional freeze-thaw cycles or freezing rain require additional resources and may result in more accidents. Loss of productive time / income for those affected by injury.	• The City mobilizes centres as required, including the Emergency Operations Centre, emergency reception and lodging centres, warming centres and community support centres • Maintain Maintenance Quality Standard (MQS) for snow / ice response for roads and city facilities. • Upstaffing when possible, increased salt to prevent slipping hazards for responders. Availability of ice cleats for all frontline staff.

4. An increase in the volume and intensity of precipitation may increase riverine flooding and cause flood-related access issues to key roadways and damage to property and infrastructure throughout the community, leading to isolation of residents and/or challenges for emergency services.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium-High Risk	High Risk	High Risk	Very High Risk	Immediate action required.
Community	High Vulnerability	Medium-High Risk	High Risk	High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• There have been localized impacts from Ottawa River flooding in the past (e.g. 300-400 homes in Constance Bay, Cumberland and Britannia communities in 2017 and 2019). 2019 Ottawa River flooding event resulted in City staff being redeployed for 2 months resulting in budgetary costs of $2 Million • A key federal asset could be impacted (e.g. if the Cliff Street heating plant was impacted the City would lose 13 miles of heating and cooling capacity) • The biggest impact will be loss of roadway or emergency access. • There are a lot of unknowns, especially with respect to the 1:350 year flood return event and the Rideau River (could cut off access to the downtown). There could be significant impacts to fire and police (especially in rural areas). • Many City departments have been significantly impacted during past events. When tied up to deal with the floods, not able to deal with day-to-day emergencies unrelated to the flood events • City resources to support communities is significant, however localized in impacted areas. Limited critical infrastructure is located within 1:100 year floodplain. Communities can be highly impacted for prolonged period where precipitation occurs during spring freshet. • Staff may be injured or made sick by prolonged work hours and exposure to contaminants in flood response. • Compounding events are a big vulnerability to the City (e.g. covid plus extreme heat, power outages plus extreme heat or cold, or flooding) • The city has emergency plans that can be implemented to provide temporary relief to residents affected by flooding, ensuring that they have a safe place to go, as well as food, clothing and other essential needs. While these	• Increased spring freshet planning response over several years. Engaged citywide partners in planning, preparation, response and recovery operations. • Working with Carleton University and Rideau Valley Conservation Authority (RVCA) for protection of Bronson Avenue/ Brewer Park community. • The new Official Plan requires developers to evaluate and mitigate risks to any proposed development within a 1:350 year flood return event (for development subject to Site Plan Control). • Flood response plans are in place for the Water Purification Plants. Long-term solutions have been identified. • The flood management risk tool includes mapping and listing of affected properties for flood events up to 1:100 year event. Interactive

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
temporary services are essential, adding supports for mental health and longer-term transitional supports will be necessary. • Local impact on residents and businesses is more profound. Insurance and personal loss may be heightened. Personal support and outreach required for vulnerable persons living in these areas. • Hazards from flooded electrical components, generator use and misuse, drowning may cause death and injury.	mapping on Ottawa.ca shows impacted properties for several flood events including a more severe flood (1:350).

5. An increase in the volume and intensity of precipitation may overwhelm sewer systems and cause flood-related access issues to key roadways and damage to property and infrastructure throughout the community, leading to isolation of residents and/or challenges for emergency services. (non-riverine flooding).

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Biggest risk is continuity of operations and providing the same level of service (e.g. paramedics)	• Emergency planning, participating in city response exercises • Continually assessing risks and liaising with service areas to collect information regarding mitigative measures that are in place. • Continue to promote emergency preparedness information to residence so that they are 72 hours prepared for disruption of services. • The Community Flood Risk Profile (FRP) identifies areas at risk of flooding from heavy rains due to inadequate stormwater management. The FRP is used to prioritize neighbourhoods for proactive measures to reduce flood risks (e.g. inlet control devices on catch basins) • Ottawa Public Health has resources on-line to help people mitigate / adapt to flooding (before, during and flood).

6. An increase in the volume and intensity of precipitation may increase the demand for establishing emergency shelters and temporary housing as populations abandon their homes during floods.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Concurrent or long duration events would stress the Paramedic Service (e.g. if an event would happen during COVID would be a challenge). Small events are manageable.	• The City has an Emergency Social Services Plan that describes the planning and coordination of an evacuation or sheltering-in-place of people impacted by an emergency.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• In an emergency, it is estimated that 10-15% of the impacted population require support. The rest stay with friends / family.	• The City has a Municipal Emergency Plan in place to better respond to the needs of the community during a major emergency, while still ensuring the delivery of city services to the other areas of the City. • On-going review of existing response plans with input from service partners. • Growing group of people understand emergency management response.

7. An increase in wind speeds and related extreme weather events, like tornadoes, may result in injuries, loss of life and damage to properties and infrastructure.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium-High Risk	Identify possible controls and continue to review for change.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium-High Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Intensity and area affected by one or more tornadoes will vary. More likely to be localized events. Historical tornadoes impacted urban and rural areas (e.g., Craig Henry / Arlington Woods, Orleans, Greenboro). Direct or incidental injuries are likely to occur and may include casualties. Impact would be localized, however significant loss of assets can be expected. • Increased demand for police services; longer-term supports for residents required • Overloaded call centres • Lots of power loss issues • Many resources are shifted to the affected areas, limiting capacity to respond elsewhere. • Note the Climate Vulnerability Risk Assessment occurred prior to the May 2022 derecho storm that caused extensive damage across many parts of Ottawa, leaving close to 200,000 without power, including thousands for a week.	• Hydro Ottawa completed a Vulnerability Assessment. Will put forward the strategic plan over the next five years to ensure that the measures are in place and infrastructure strengthened to deal with the increase in weather events. • The City has a Municipal Emergency Plan in place to better respond to the needs of the community during a major emergency, while still ensuring the delivery of city services to the other areas of the City. • Ongoing review of existing response plans with input from service partners.

8. An increase in multi-day ice storm events may result in damages to communication systems and electricity grids, impacting communication, transportation and emergency systems.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium-High Risk	Identify possible controls and continue to review for change.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium-High Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Historical impacts ranged in severity. The impacts have resulted in increased wear and tear on equipment (due to continuous operation). • Loss of cell phone service would cripple paramedics ability to respond to most calls, also community's ability to call through to the 9-1-1 system. Emergency response is very reliant on communications and electricity; damages to these infrastructures severely impacts response operations. • Workers would be impacted as they need to be redeployed to facilities that have power. • Rural communities may be more impacted by power outages. • City fuel sites and fleet repair shops without generator backup would not operate in an extended outage. • Existing impacts have resulted in damage to facilities, business interruption, inability to staff to access and product to be moved.	• The City has a Municipal Emergency Plan in place to better respond to the needs of the community during a major emergency, while still ensuring the delivery of city services to the other areas of the City. • Municipal Emergency plan is reviewed annually. • Working with other city departments to look at alternatives to improve rural connectivity. • Provide public education and awareness regarding emergency preparedness. • Maintain Continuity of Operations Plan for critical services that need to continue. • Maintain Crisis Communications Plan. • The City is reviewing the need for generator adaptability to facilities that may be needed in the case of severe weather events. The City is also reviewing contracts with service operators' contractors to ensure these events are captured in their contracts. (e.g., diesel fuel delivery) • Bell has systems that perform remote monitoring of temperature and energy consumption of City facilities. Such systems send early warnings of critical temperature variations, which allow them to take action before damage occurs to our facilities.

9. An increase in the frequency, duration and intensity of extreme weather events may reduce the ability of the City, community service providers and social support systems to provide services and effectively respond to simultaneous and future events.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
Community	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Increased strain on First responders. • Extended responses are difficult to maintain. Lost staff hours and staff; long term health impacts; short term inability to respond/ capacity challenges; financial impacts (Workplace Safety and Insurance Board (WSIB)/lost time/etc.) • Impacts from extreme weather events require support for response and recovery operations which impacts business continuity of many departments. • As staff are diverted / redeployed, most residents are oblivious unless the impacts affect them directly. Residents want to see business continuity. • The community has limited capacity to absorb additional strains and impacts. Service providers are over-extended. Significant investments in mental health supports and training for workers are essential. • Social systems are already underfunded and overburdened. Adding even more work to these individuals and organizations could easily lead to system collapse. As budgets have stagnated for community responses, many other agents (paramedics, police, etc.) have had to step in and fill the	• The City is reviewing the need for generator adaptability to facilities that may be needed in the case of severe weather events and reviewing contracts with service operators' contractors to ensure these events are captured in their contracts. (e.g., diesel fuel delivery) • Utilize and hire casual staff for additional support. • Review and improve internal emergency plans and business continuity plans. More staff have been trained in emergency response and are prepared to support emergency response.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
gap at a dramatically increased cost, and sometimes increasing the health and safety risks to residents. • Not for profits are not equipped to deal with an increased in demand for emergency services. • Most City facilities and buildings have back-up power for limited lighting and some critical systems. It is estimated that 1/3 sump pumps at City facilities do not have back up power (a greater proportion of community-owned buildings lack back-up power). • Power outages longer than a day are a problem (e.g., food; how to move people (e.g., 1998 ice storm or during extreme heat); this is further complicated when there are compounding events (e.g., sump pumps do not work when an outage occurs during a flood or in cold snaps).	• Continue to promote emergency preparedness information to residence so that they are 72 hours prepared for disruption of services

10. An increase in the frequency, duration and intensity of extreme weather events may increase personal stress such as anxiety, depression, violence, especially for individuals with pre-existing mental health issues.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Those that do not have insurance, limited insurance and/or low-income tend to have higher / compounded stresses. Communities that have experienced an increase in emergency situations (i.e. West Carleton experiencing floods and tornado) are likely to experience an increase in mental wellness impacts. • During historical extreme events, stress and anxiety is high and is taken out on First responders. Untrained City staff and volunteers were also impacted. • City staff who have been involved in significant emergency response operations over the past few years (floods, tornadoes, COVID-19) are more prone to experience mental wellness impacts. • Many individuals in Ottawa lack access to mental health care and supports. Ongoing lack of supports, especially for mental health and complex cases, can be exacerbated by increased demand (social systems are the vulnerability)	• City is developing A Poverty Reduction Strategy. • The community has mental health outreach services and the province has a medical team to support mental health in a crisis.

11. An increase in extreme weather events may increase the risk of damage to livestock and the need for the City to support the emergency disposal of deadstock.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Under provincial regulations deadstock must be appropriately disposed of to ensure deadstock do not pose health and safety concerns. This would be particularly relevant (urgent) in the warmer season as the deadstock will rapidly decompose. • There was a recent fire that had over 80 cows perish.	• The City often supports and coordinates with the Province on this.

12. Global climate change may cause supply chain instability and/or market failures impacting the availability and costs of goods and services which could impact emergency services.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• The duration of the events is what will impact the supply chain. The City is using the lessons learned from the pandemic to increase stockpiles. • Increased costs impact budgets, which can result in decreased services as priorities may change due to budget pressures • Access to commodities in demand for a specific event is another concern, supply of sandbags became a concern in 2019 freshet. • Fuel became a big issue after the tornadoes to ensure that emergency services had access to fuel. • If there is a diesel/ethanol fuel shortage and none of the large distributors had product available for the City then the fleet would be grounded, as existing City fuel tanks can only hold a few days' worth of fuel for normal operations. • Increased pressure on housing, community services, like food banks and increased pressure on vulnerable populations. • Vulnerable families are expected to be pushed to poverty resulting in an increased need for social assistance. These impacts will escalate as incomes become lower.	• Continue to review the continuity of operations plans and continue to review the personal protective equipment stockpiling procedures and plans. • The City has systems in place to ensure proper fuel and diesel levels are maintained (e.g., Standing Offers and priority supply). • Food security initiatives – e.g., Grow An Extra Row program where residents are growing an extra row of food for local food banks.

D.7 Natural Environment

Natural environment encompasses climate impacts on trees and forests, watercourses, lakes, wetlands and other natural areas and habitats, as well as biodiversity.

The following tables include a summary of the noted impacts, vulnerabilities and possible consequences on the Focus Area. Following this table are the impact statements used in the Climate Vulnerability and Risk Assessment (CVRA) along with specific vulnerability / consequence notes and ratings at the City and community scale.

Table D.7 Summary of Focus Area Impacts, Vulnerabilities and Consequences by Climate Hazard Theme

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Extreme Heat, Drought and Humidity 	• Reduced aquifer recharge, baseflow and degraded aquatic habitat • Increased tree and ecosystem instability, habitat shifts, habitat loss, loss of forest cover, decline in some native species • Reduced water quality (algal blooms) • Increased risk of wildfires	• Smaller creeks that run dry in warm summers; Rideau River relies on reservoir lakes in Perth • Urban trees and forests susceptible to heat (e.g. sugar maple) • Drought increases the vulnerability of trees and plants to invasive impacts (including Emerald Ash Borer); pesticides can be less effective in drought • Introduction and establishment of new invasive species (insects and disease). • Anticipate changing phenology of existing forest insects and disease that will impact tree and forest cover and shift range and behaviour of pests. • Algal blooms have impacted some waterways e.g. Rideau River and Canal, Constance Lake, and stormwater ponds	• Lost tree canopy and terrestrial ecosystems • Reduction in watercourse baseflow impacts aquatic habitat • Increased forest management to reduce fire risk • Hazardous algal blooms can kill pets and wildlife e.g. anything that drinks it.
Seasonal Variability 	• Increased spread of invasive species, insect pests and disease • Increased risk of disease vectors and illnesses spreading • Reduced water quality from increased salt application • Increased tree and ecosystem instability, habitat shifts and/or habitat loss from increased salt and winter freeze-thaw	• Increased spread of Wild Parsnip and Giant Hogweed already occurring • Invasive forest insects like Emerald Ash Borer (EAB) and Dutch Elm can be expected to be more severe when trees are stressed from drought and extreme weather • Maple species comprise a large percentage of forest cover and could be severely impacted by a pest like Asian Long Horn Beetle • No comprehensive province-wide pest risk analysis has been completed for invasive species or native species that will shift in behaviour and phenology under climate change • Limited capacity to track and manage emerging species of concern. Focus is on species that impact health and safety • Freeze-thaw stresses trees and root systems • Road salt limits urban tree's ability to reach maturity	• Significant loss of tree canopy (e.g. ~25% EAB loss) has high social, health and economic consequences • Increased impact on species at risk and associated City response • Increased stress on wildlife and change of migration patterns • Overuse of existing parks resulting in damage to trees and amenities. • Social, spiritual, health impacts of changing landscapes - e.g. loss of tree

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
		• The City has a salt management program, but it does not apply to private property (e.g. private parking lots)	species for cultural practices (e.g. birchbark)
Precipitation Volume and Intensity 	• Shoreline erosion / bank destabilization / habitat loss • Reduced water quality from increased stormwater runoff • Increased agricultural run-off and sediment loading in aquatic systems • Increased tree and ecosystem instability, habitat shifts and/or habitat loss and tree damage	• Urban creeks in areas with minimal stormwater management • Rural creeks subject to increased agricultural runoff • Watercourses and ravines susceptible to erosion and retrogressive landslides, including areas of sensitive marine clay	• Accelerated shoreline erosion • Retrogressive landslides • Increased tree damage, maintenance and emergency response • Increased demands for creek and ravine management
Extreme Events 	• Increased tree mortality/ damage • Shoreline erosion/ bank destabilization / habitat loss • Increased agricultural run-off and sediment loading	• Trees and ecosystems already stressed by the impacts of climate change (e.g., drought) are more vulnerable to extreme events • Urban trees more vulnerable than natural areas / forests • Loss of tree canopy	• Electricity or communication interruptions / blackouts due to trees falling on electricity lines. • Increased tree damage and removal, storm response, claims and property damage. • Increased pressure on tree replacement programs • Health and safety risks from hazard trees • Blocked culverts and drainage

The following table presents a summary of the Natural Environment Focus Area Impact Statements. Details on the ratings for each Impact Statements follows below.

	Impact Statement	City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
1.	Hotter and drier summers may increase the likelihood of summer drought, leading to an increase in tree and ecosystem instability and habitat loss and management requirements.	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.
2.	Hotter and drier summers may affect river flows, water temperatures and dissolved oxygen levels leading to degraded aquatic habitat and/or increased mortality of fish and other aquatic organisms.	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required.
3.	Hotter and drier summers may result in reduced aquifer recharge, which may result lower baseflow to streams and degraded aquatic habitat.	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required.
4.	Hotter and drier summers may result in reduced aquifer recharge, which increase the occurrence of dry wells on private lands.	Low Vulnerability	Low Risk	Low Risk	Low Risk	Low Risk	Continue to manage through existing controls and procedures	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Develop a plan to address risk.
5.	Hotter and drier summers may increase the likelihood of urban and rural wildfires resulting in harm and damage to forests and settlement areas and additional strain on forest management / wildfire suppression programs and resources.	High Vulnerability	Medium Risk	High Risk	High Risk	High Risk	Develop a plan to address risk.	High Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	Medium-High Risk	Develop a plan to address risk.
6.	Hotter summers and longer spring and fall seasons may result in increased migration of wildfowl resulting in water quality issues.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review

	Impact Statement	City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
							review for change.						for change.
7.	An increase in seasonal winter freeze thaw events may increase road salt use and could accelerate the susceptibility / mortality of salt-weakened plants and trees to insects, pathogens and extreme weather.	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Develop a plan to address risk.	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Develop a plan to address risk.
8.	An increase in seasonal winter freeze thaw events may increase road salt use and result in reduced riverine and shallow well water quality.	Low Vulnerability	Low Risk	Low Risk	Low Risk	Low Risk	Continue to manage through existing controls and procedures	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
9.	Changes in seasonal temperatures and duration may increase the speed to which eco-regions shift leading to increased spread of invasive species, disease (e.g., Emerald Ash Borer or Dutch Elm Disease) and extinctions of local flora and fauna.	Medium Vulnerability	High Risk	High Risk	Very High Risk	Very High Risk	Immediate action required.	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Immediate action required.
10.	Changes in seasonal temperatures and duration may increase ecosystem productivity where adequate water is available.	Low Vulnerability						Low Vulnerability					
11.	Changes in seasonal temperatures and duration may shift the timing of natural life cycle processes for flora and fauna leading to a change in the timing for protecting breeding birds and breeding amphibians/ reptiles.	Medium Vulnerability	Low Risk	Low Risk	Low Risk	Low Risk	Identify possible controls and continue to review for change.	Low Vulnerability					
12.	An increase in the volume and intensity of precipitation may increase the saturation of sensitive	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.

	Impact Statement	City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
	marine clay resulting in damage / loss of ecosystems and property.												
13.	An increase in the volume and intensity of precipitation may lead to erosion of riverbanks and ravines and cause bank destabilization, property damage, loss of habitat, and Reduced water quality.	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.
14.	An increase in volume and intensity of precipitation may result in increased stormwater runoff or combined sewer overflows resulting in poor surface water quality and degraded habitat.	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
15.	An increase in multi-day ice storm events may damage trees, forests, parks and trails leading to damaged public, private property, parks and recreational facilities.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.	Medium Vulnerability	Low Risk	Low Risk	Low Risk	Medium Risk	Identify possible controls and continue to review for change.
16.	An increase in extreme wind and weather events (e.g. ice storms, lightning, etc.) may result in more power outages from trees falling on power wires.	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.

1. **Hotter and drier summers may increase the likelihood of summer drought, leading to an increase in tree and ecosystem instability and habitat loss and management requirements.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.
Community	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Trees and ecosystems are already stressed by drought. Increased mortality expected for some tree species (e.g., sugar maple) though needs to be monitored as there is limited information on how a tree species will respond to drought. • More attention needed to understand driving factors/ trends for tree mortality (capacity gap) • Increased operational requirements • Water conservation Bylaws may be activated during dry periods limiting watering of vegetation. • This is a compounding issue – for e.g. drought increases the vulnerability of trees and plants to invasive impacts. South March Highlands saw mortality in last drought - made space for new species including invasive species (dog strangling vine) • Hotter and drier temperatures create variable soil conditions that can lead to property damage from trees. • Very low water conditions in small creeks in SNC watershed (creeks run dry in the summer). These areas are at higher risk. • The loss of more trees in the community could have a severe impact on the quality of life for residents (e.g. reduced shade on streets and in parks), especially because replacement trees will take a long time to mature.	• Increased tree watering on newly planted trees, and extended watering of Commemorative trees beyond the 3-year establishment period • Nursery stock consider tree species more typically grown in warmer tree hardiness zones. • Planting plan will consider heat islands, plantable locations (from forest cover analysis) and low-income vulnerable populations. • Rural tree planting programs (e.g. Green Acres or roadside windrows) • Participating in Regional Forest Health Network for awareness, training, and preparation for upcoming insects, pests, and diseases that could impact Ottawa's forest. • Increasing tree protection monitoring and enforcement in Infill Areas. • The City currently has a good inventory of city street trees, working on park trees inventory now.

2. **Hotter and drier summers may affect river flows, water temperatures and dissolved oxygen levels leading to degraded aquatic habitat and/or increased mortality of fish and other aquatic organisms.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
Community	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Hotter and drier summers will result in less water entering the river directly and through overland flow. • Some lakes have had reduced water quality (Rockcliffe Pond) • Algal blooms have impacted some areas along waterways in Ottawa e.g., Rideau Canal, Constance Lake, and storm water ponds.	• The City completes annual inspection of stormwater management facilities • The City is implementing polices that require lands within the minimum setback to remain in a naturally vegetated condition to protect ecological function and to restore any natural

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Lower water levels impact the quality of water at public beaches and impacts ability for people to swim if the water levels become too shallow. • Lower water levels could result in concentrated nutrient levels and warmer water that create conditions for the growth of hazardous algal blooms. These blooms can result in fish kills and unsafe recreational use (e.g., swimming, fishing, boating). • Rideau Valley relies on reservoir lakes in Perth - if not properly filled, could impact the Rideau River • Mississippi watershed has experienced four droughts since 2012. Recent occurrences of Harmful Algae Blooms on Mississippi and Dalhousie Lakes may be attributed to warmer temperatures in the early fall.	vegetation that is disturbed due to development. • New Official Plan requires subwatershed assessments to incorporate future climate conditions. • Ottawa Public Health gets alerted when there is a hazardous bloom so they can do outreach. Mostly affects lakes and recreational activities. • Lemieux intake is being lowered to ~20m to address Frazil ice (Britannia is already deep) which will also reduce the risk of an algae bloom affecting water quality. • Baseline water quality monitoring program and Conservation Authority monitoring of smaller watercourses is in place which allows for tracking / comparison of data over time.

3. Hotter and drier summers may result in reduced aquifer recharge, which may result lower baseflow to streams and degraded aquatic habitat.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
Community	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Already seen very low water and drought conditions which strain aquifers and streams (e.g. small creeks run dry in SNC watershed). • Hotter and drier summers will result in less water entering the river directly (and through overland flow), but baseflow (which is the groundwater contribution to streamflow) will also decrease. Reduction in baseflow has the potential for serious consequences to aquatic habitat and aquatic organisms. • Some lakes have had reduced water quality (Rockcliffe Pond) • Lower water levels could result in concentrated nutrient levels and warmer water that cause the growth of hazardous algal blooms. These blooms can result in fish kills and unsafe recreational use (e.g. swimming, fishing, boating).	• Baseline water quality monitoring program and Conservation Authority monitoring of smaller watercourses is in place which allows for tracking / comparison of data over time. • New Official Plan requires subwatershed assessments to incorporate future climate conditions.

4. Hotter and drier summers may result in reduced aquifer recharge, which increase the occurrence of dry wells on private lands.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability	Low Risk	Low Risk	Low Risk	Low Risk	Continue to manage through existing controls and procedures.
Community	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Reduced aquifer recharge may also result in dry private shallow wells and the need to drill new deeper wells. • South Nation's watershed is 70% rural and in the 2012 drought water had to be trucked in and many private wells were dug deeper. • If water shortages in private wells become more frequent, the City could be called upon to provide more reliable service to those on private wells. • Irrigation sources could be impacted resulting in health and safety issues.	• New Official Plan requires subwatershed assessments to incorporate future climate conditions. • Deeper wells.

5. Hotter and drier summers may increase the likelihood of urban and rural wildfires resulting in harm and damage to forests and settlement areas and additional strain on forest management / wildfire suppression programs and resources.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium Risk	High Risk	High Risk	High Risk	Develop a plan to address risk.
Community	High Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	Medium-High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Occasional grassfires and peat fires have caused air quality issues for residents. • 80% of City is rural and 30% is forested. Many communities at risk (e.g. Constance Bay: Pine forest on sand in middle of village; new community on Hwy 7; Carp ridge with forest on shallow soils; individual homes in Marlborough forest). • There is a substantial number of areas that would meet the provincial ratings for medium to high risk of wildfire based on tree species (e.g. white cedar). • Potential for wildfires is very high (e.g. small brush fire could get a bit of wind and then much harder to contain).	• The Urban Forest Management Plan requires the completion of tree inventory, forest canopy cover analysis, and sets tree planting / establishment guidelines. • The City will complete a wildland fire risk assessment for all City-owned forested areas • The City has education and awareness campaigns around 'Be prepared for 72 hours'. • Ottawa Public Health plans to undertake a Climate Change and Health Vulnerability Assessment for Wildfires in 2022. • Preventative actions include control of authorized fires size and content through fire permitting process and issuance of fire bans due to environmental conditions. • Ottawa Fire Services staff are regularly trained in dealing with wildland fires and have an open-ended agreement with Ministry of Natural Resources to be available should they require their services. • Rural fire units work with landowners to minimize risk (e.g. peat, tires, nutrient stockpiling).

6. Hotter summers and longer spring and fall seasons may result in increased migration of wildfowl resulting in water quality issues.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Increased geese numbers have impacted water quality. • Shorter, milder winters could see more geese and ducks wintering in the city. • May see more frequent beach closures as a result of increased E. coli contamination in the rivers. • City may incur increased costs for waterfowl management programs (e.g. water circulation pumps, gull wires, goose hazing etc.). Water quality impacts associated with waterfowl would be felt over the shorter term and are reversible.	• Programs to deter birds at beaches (egg addling, decoys, drones) • Education and awareness programs including garbage disposal at parks and beaches, and Wildlife Speaker Series.

7. An increase in seasonal changes may increase road salt use and could accelerate the susceptibility / mortality of salt-weakened plants and trees to insects, pathogens and extreme weather.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Develop a plan to address risk.
Community	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Urban trees (hard service planting) are more susceptible to freeze thaw impacts because of the surrounding environment. • Road salt has a significant impact on the likelihood that urban trees reach maturity. • The tree canopy is already under significant stress from age, disease, and damage during development. • The City does have a salt management program, but it does not apply to private property. Large private parking lots, cumulative impacts of residential use are big factors that need to be addressed. • The replacement of trees is expensive.	• Salt Management Plan • Urban Forest Management Plan

8. An increase in seasonal winter freeze thaw events may increase road salt use and result in reduced riverine and shallow well water quality.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability	Low Risk	Low Risk	Low Risk	Low Risk	Continue to manage through existing controls and procedures.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Based on past groundwater studies, shallow wells i.e. dug wells are more vulnerable to high chloride. High chloride level will impact aesthetics and taste. Costs to dig deeper private wells. • The City's municipal wells are not currently impacted by road salt, this is assessed annually as part of the annual source protection reporting, where the chloride level in municipal wells is reviewed. Road salt was assessed as part of the source protection assessment report as a potential significant drinking water threat, which completed calculations based on the percentage of impermeable surface within the wellhead capture zones (as per Ministry of Environment, Conservation and Parks (MECP) methodology). Road salt was not considered a SDWT based on the calculations at the City's municipal well; however the calculation methodology is being amended and will need be re-assessed in the future. • More freezing rain means more salt and thus more areas to store it. Storage of salt needs to be done appropriately to not contaminate wells. • The City does have a salt management program, but it does not apply to private property. Large private parking lots and cumulative impacts of residential use are big factors that need to be addressed	• The City and conservation authorities mitigate risks to well head protection areas through the Source Protection Plans. • The City has a salt management plan, aiming to reduce salt use over the long term. • Annual monitoring.

9. Changes in seasonal temperatures and duration may increase the speed to which eco-regions shift leading to increased spread of invasive species, disease (e.g., Emerald Ash Borer or Dutch Elm Disease) and extinctions of local flora and fauna.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	High Risk	High Risk	Very High Risk	Very High Risk	Immediate action required.
Community	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Increased spread of Wild Parsnip and Giant Hogweed already occurring, and European buckthorn • Emerald Ash Borer has been more severe on trees stressed from drought and extreme weather • Maple species are 40% of forest cover and could be severely impacted by a pest like Asian Long Horn Beetle • No province wide pest risk analysis has been completed • Limited capacity to track and manage emerging species of concern. Focus is on species that impact health and safety • Municipalities and Conservation Authorities estimated to spend $50 million per year on invasive species in Ontario. • Native pests/ diseases will have different behaviours in the future (not being monitored)	• Increased tree planting and removal; species selection adjusted • Changing mowing frequencies and spray programs. • Developing stewardship programs to manage invasive species in natural areas and to help monitor changes. • Participating in Regional Forest Health Network for advanced awareness, training, and preparation for upcoming insects, pests, and diseases that could impact Ottawa. • Education and awareness programs on health impacts of invasive species and pests • 2022 Tree Planting Plan will look at existing cover and risks • Updates to policy documents (e.g. Environmental Impact Study guidelines and Urban Forest Management Plan).

10. Changes in seasonal temperatures and duration may increase ecosystem productivity where adequate water is available.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Vegetation and tree growth results in more maintenance (e.g. increased pruning) • Increased air temperatures cause more low air quality and ground level ozone which can impact tree health – this should impact tree species selection since some species exacerbate this effect. • Allergens such as tree and plant pollen will increase in concentration as a result of increased productivity. This can impact anyone with pollen allergies and could place strain on low income households because allergy medication costs are not covered by public health insurance.	• None noted.

11. Changes in seasonal temperatures and duration may shift the timing of natural life cycle processes for flora and fauna leading to a change in the timing for protecting breeding birds and breeding amphibians/ reptiles.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Low Risk	Low Risk	Low Risk	Low Risk	Identify possible controls and continue to review for change.
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Pollinators have an important role to play in the natural fertilization of crops, fruit trees, etc. Any seasonal changes will likely disrupt pollinator lifecycles until a new natural equilibrium is reached. It may be necessary to resort to artificial methods of pollination and/or managed pollinators in the meantime. • Shortened time for tree clearing and construction projects • Anticipating that the timing would shift it earlier in the year, which may lead to a shortened construction season (due to changes to land animals) • More pressure on park naturalized spaces.	• None noted.

12. An increase in the volume and intensity of precipitation may increase the saturation of sensitive marine clay resulting in damage / loss of ecosystems and property.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.
Community	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Saturation of clays that might be susceptible to land slides or land flows are a concern from prolonged rain events - also considered an unknown. Retrogressive land slides happen in wet season (from South Nation) • Shifting slopes with sensitive marine clay has resulted in increased tree removals or site reinstatements. • Many properties are built on sensitive clay and could be at risk (hotter and drier in the summer and then saturation in other seasons) • Almost all new developments areas are on sensitive marine clays, but there are policies on tree planting. • Lack of geotechnical capacity at City in department review is a gap.	• Stream restoration projects to improve erosion control. • Policies for the number and type of trees that can be planted in sensitive marine clay

13. An increase in the volume and intensity of precipitation may lead to erosion of riverbanks and ravines and cause bank destabilization, property damage, loss of habitat, and reduced water quality.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.
Community	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Historical impacts (e.g. Bilberry Creek landslide) resulted in slipping creek/ ravine banks and damage to infrastructure (pathways, rinks, light poles, bridge piers, trees). Mud creek is also noted to be vulnerable. • Property damage and costs will depend on the scale of the event. • Inadequate City programs to properly manage stream corridors and ravines. • Current stormwater drain maintenance is reactive. • Developers are increasingly building communities close to ravines. Many properties are built on sensitive clay and could be at risk (hotter and drier in the summer and then saturation in other seasons). • Saturation of clays that might be susceptible to land slides or land flows are a concern from prolonged rain events (e.g. retrogressive land slides in South Nation).	• Stream restoration projects to improve erosion control.

14. An increase in volume and intensity of precipitation may result in increased stormwater runoff or combined sewer overflows resulting in poor surface water quality and degraded habitat.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• More intense precipitation may lead to increased water flows, erosion and sediment inflow into stormwater systems and impact performance levels and water quality. • Increased stormwater runoff causes extreme variation to water level and flow, making the stream vulnerable to erosion and pollutants (especially at outfalls). This adversely impacts the safety of accessing these streams and can be harmful to aquatic species. • Buried / covered streams also significantly impact aquatic ecosystems.	• Stormwater management requirements for new development will consider future climate conditions, • Stormwater Management Retrofit Plans for older areas of the city. • Monitoring of local precipitation data from automated tipping buckets and Combined Sewer Overflow notifications. • Ottawa Public Health (OPH) tests the water quality daily at public beaches and issues a no-swim advisories if warranted. OPH uses a rainfall rule to support decision making around safety of swimming at public beaches following rainfall events. • The Combined Sewer Storage Tunnel provides sewage overflow storage during major rainfall events to reduce combined sewer overflows (CSOs). The design of CSST was based on a significant historical event plus 15% to account for increased precipitation.

15. An increase in multi-day ice storm events may damage trees, forests, parks and trails leading to damaged public, private property, parks and recreational facilities.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
Community	Medium Vulnerability	Low Risk	Low Risk	Low Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Increased tree damage and removal, storm response, claims and property damage. • Natural areas / forests are well adapted, but urban forests are not (due to the hard infrastructure around the trees). • Significant downed trees / hazard trees result in increased operations and maintenance. • There are many mature large canopy trees in Ottawa that are vulnerable to extreme wind damage (e.g., Arlington Woods). • Closures of parks and facilities.	• Training on tree risk assessment. • Proactive pruning programs • Right tree species selection to tolerate winter maintenance • Change to hard surface designs

16. An increase in extreme wind and weather events (e.g. ice storms, lightning, etc.) may result in more power outages from trees falling on power wires.

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Storm driven power outages have impacted safety requirements (refrigeration, disinfection) at various institutions. • Increase in demand on Public Health Inspectors; and debris and forest cleanup.	• The City undertakes emergency planning for power outages. • Promotion of emergency preparedness information to residents so that they are 72 hours prepared for disruption of services. • The City shares information about food safety during a power outage.

D.8 Parks and Recreation

Parks and Recreation encompasses outdoor park facilities as well as indoor and outdoor recreational programming, for both City spaces and services, and programs offered by other public and private partners. Note that the Buildings and Facilities Focus Area considered impacts on City facilities such as arenas and pools.

The following tables include a summary of the noted impacts, vulnerabilities and possible consequences for the Focus Area. Following this table are the impact statements used in the Climate Vulnerability and Risk Assessment (CVRA) along with specific vulnerability / consequence notes and ratings at the City and community scale.

Table D.8 Summary of Focus Area Impacts, Vulnerabilities and Consequences by Climate Hazard Theme

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Extreme Heat, Drought and Humidity 	• Increased demand for cooling facilities like splash pads, outdoor pools and beaches • Increased demand for shaded parks and recreational facilities • Increased demands for cooled indoor recreational spaces • Increased health and safety risks during extreme heat events at outdoor facilities (splash pads or play equipment) or artificial sports fields • Increased degradation of sports fields • Reduced water quality at beaches or other swimming areas	• Limited availability and size of parks create challenges for space for trees alongside recreation amenities (especially in downtown and inner urban areas) • Shading sails are an option to mitigate heat, but require increased maintenance and cost • Extending opening of supervised beach and outdoor pools is limited by seasonal staffing availability	• Increased costs to improve and operate indoor and outdoor amenities (and extend opening hours) • Cancelled City programming or services in community buildings where there is no A/C (e.g. churches, City community buildings, fieldhouses, etc.) • Cancelled or delayed sporting events or outdoor recreation • Reduced attendance at sporting events. • Increased waterfront management (e.g. water circulation pumps, waterfowl management) • More frequent beach closures as a result of increased E. coli contamination in the rivers. • Residents may need to travel outside their community to access facilities with air conditioning (programs may be more expensive or oversubscribed)

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Seasonal Variability 	• Restrictions / closures of park and recreation areas or amenities (e.g., outdoor rinks) • Increased spread of invasive species and insect pressures • Increased risk of disease vectors and illnesses spreading • Increased tree and ecosystem instability, habitat shifts and/or habitat loss • Overuse of existing parks	• Outdoor rinks will be more difficult to maintain. The new Parks and Facilities Master Plan calls for 36 new outdoor rinks by 2031 and possibly three new, additional outdoor refrigerated rinks. • Springtime variability affects opening of sports fields (e.g. from increased rains and freezing rain). • Invasive species control programs pose great challenges due to costs and scale. Strategy is to focus on species that pose health risks and try to manage new invasive species before they become established. • The tick *Borrelia burgdorferi* that can carry Lyme disease is now prevalent in Ottawa and has been found on 60% of National Capital Commission greenbelt trails.	• Increased demand for alternative recreational amenities (i.e., refrigerated rinks) • Increased cooling costs (e.g. refrigerated rinks) and GHG emissions • Increased costs due to required facility retrofits (cooled facilities) or maintenance regimes (e.g. invasive species) • More frequent program/rental cancellations and loss of City revenue • Environmental damage to trees and amenities. If new parkland is not available, existing facilities will suffer environmental damage.
Precipitation Volume and Intensity 	• Restrictions / closures of park and recreation areas	• Parks and recreational areas prone to saturation • Parks and recreational facilities in flood-prone areas next to watercourses (e.g. Brewer Park, Windsor Park, Brantwood Park, Britannia, Petrie Island) • Increased pressure to integrate stormwater management in parks, which reduces their functionality	• Park closures • Delayed opening • Reduced revenues (e.g. sports fields/ball diamond rentals) • Increased costs to repair damages • Loss of use of recreational shoreline space/City beaches due to high E.coli counts
Extreme Events 	• Increased tree and ecosystem instability, habitat shifts and/or habitat loss • Damaged / compromised park and recreational assets	• Natural areas are pretty resilient, but urban areas can require substantial restoration. • Ice damage to shoreline properties	• Restrictions / closures of park and recreation areas • Reduced revenues and increased costs to repair damages • Loss of recreational services if facilities are used in emergencies • Planning and programming required to re-establish and rehabilitate natural forest areas.

The following table presents a summary of the Parks and Recreation Focus Area Impact Statements. Details on the ratings for each Impact Statements follows below.

	Impact Statement	City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
1.	Hotter summers and changing shoulder seasons may necessitate changes to recreation facilities, such as increased demand for pools, splash pads, wading pools and beaches.	High Vulnerability	Medium-High Risk	High Risk	High Risk	High Risk	Immediate action required.	Medium Vulnerability	Medium-High Risk	High Risk	High Risk	High Risk	Immediate action required.
2.	Hotter summers may increase the potential risk of burns from asphalt at splash pads and metal slides.	Low Vulnerability						Low Vulnerability					
3.	Hotter summers may increase the demand for shaded areas in parks and construct additional indoor recreational facilities.	Medium Vulnerability	Medium-High Risk	High Risk	High Risk	High Risk	Immediate action required.	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Develop a plan to address risk.
4.	Increased extreme temperatures and/or high humidex periods may increase the health risks for athletes or active recreation users, especially on surfaces that exacerbate the urban heat island effect.	Medium Vulnerability	Medium-High Risk	High Risk	High Risk	High Risk	Immediate action required.	Medium Vulnerability	High Risk	Very High Risk	Very High Risk	Very High Risk	Immediate action required.
5.	Increased extreme temperatures and/or high humidex periods may cause park and recreation project delays, reduced service levels and extra costs to the City in order to protect worker health and safety.	Medium Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	Medium-High Risk	Develop a plan to address risk.	Low Vulnerability					
6.	Unusually hot temperatures and/or high humidex periods may result in an increased demand for upgrading buildings and facilities.	Medium Vulnerability	Medium Risk	Medium Risk	High Risk	High Risk	Develop a plan to address risk.	Medium Vulnerability	Medium Risk	Medium-High Risk	Very High Risk	Very High Risk	Immediate action required.
7.	Rising temperatures and changing seasons may increase the use of existing parkland and result in increased environmental damage and degradation from use.	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review

Impact Statement		City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
													for change.
8.	Warmer, shorter winters and reduced snowfall may negatively impact winter / outdoor park programming and facilities (e.g., planning, resources, lifecycle costs).	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Develop a plan to address risk.	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Develop a plan to address risk.
9.	An increase in seasonal temperatures and/or stagnant waters from flooding may lead to intensification of existing disease vectors, and the migration of new disease vectors and illnesses into the community.	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Immediate action required.	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	Medium-High Risk	Immediate action required.
10.	Increased precipitation and other contributing factors (e.g., unmanaged stormwater) may lead to reduced water quality at beaches and natural outdoor swimming areas resulting in conditions that are not favorable to use and reduced recreation and tourism opportunities.	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required.
11.	An increase in the volume and intensity of precipitation may result in the flooding of parks, sports fields, and outside event spaces, resulting in park closures and loss of recreational opportunities.	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.	Medium Vulnerability	Low Risk	Low Risk	Low Risk	Medium Risk	Identify possible controls and continue to review for change.
12.	An increase in extreme wind and weather events may damage trees, forests, parks and trails leading to damaged public and private property and temporary closures of outdoor public spaces including parks and recreational facilities.	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.

Impact Statement		City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
13.	An increase in extreme weather events, such as high winds, can result in impacts to recreational and shoreline assets.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

1. **Hotter summers and changing shoulder seasons may necessitate changes to recreation facilities, such as increased demand for pools, splash pads, wading pools and beaches.**

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	High Vulnerability	Medium-High Risk	High Risk	High Risk	High Risk	Immediate action required.
Community	Medium Vulnerability	Medium-High Risk	High Risk	High Risk	High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Impacts staffing as many are summer students and constrained by the school term. Staff may be harder to hire due to weather shifts (e.g. hotter to work outside). • Overcrowding at beaches has become a concern. • Droughts may limit water availability for outdoor cooling (e.g., splash pads, pools, etc.) • Pools are concentrated in the downtown core. The cost to operate pools are high. • Feedback from residents is that splash pads already close too soon and do not provide enough imaginative play or swimming feeling. The cost to build and maintain these water facilities are high. • Increase in operating hours has resulted in increased pressure on operating budgets and decreased/ delayed maintenance and renewal. This may result in the delaying of redevelopment of some facilities.	• The Recreation, Cultural and Facilities Services department (RCFS) has a policy in place to adapt aquatics programs and public swims at all City of Ottawa pools to provide relief when a Heat Alert, Heat Warning or Heat Emergency is declared. • RCFS has a process in place to ensure availability of splash pad locations city-wide for access during heat alerts, heat warnings and heat emergencies. • RCFS has a policy in place to ensure availability and staffing of public beach locations city-wide for access during heat alerts, heat warnings and heat emergencies (limited to June and July due to staffing availability).

2. **Hotter summers may increase the potential risk of burns from asphalt at splash pads and metal slides.**

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Installed equipment has caused concern and service calls in the past, including claims for burns. Installation design have changed as a result (e.g., orientation, colour). • Amenities such as court surfaces can have different colours to reduce the heat, but they come with a higher capital cost and more maintenance. For example, white asphalt radiates heat from asphalt surface by as much as 10 degrees; however more expensive than traditional asphalt (but not as expensive as concrete). • More shade-producing sail type structures could be installed subject to budgets and maintenance.	• Choose lighter coloured play equipment components, orient slides to north and east where possible, and use light coloured paint finishes on splash pad control vaults. • Plant trees in locations that will cast shade through hottest parts of the day.

3. Hotter summers may increase the demand for shaded areas in parks and construct additional indoor recreational facilities.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium-High Risk	High Risk	High Risk	High Risk	Immediate action required.
Community	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Limited availability and size of parks create challenges for space for trees alongside recreation amenities (especially in downtown and inner urban areas) • Shading sails are an option to mitigate heat but require increased maintenance and cost. Although these shade shields are great source of shade, they are limited to the number of users which can use at once. Space is limited due to developed parks and accessibility. • May need to consider shading structures over seated areas (e.g., track and field and sports fields). • Increased costs to improve and operate indoor and outdoor amenities (and extend opening hours). Residents may need extended access to facilities if they do not have access to their own cool space. • Extending opening of supervised beach and outdoor pools is limited by seasonal staffing availability. • Narrower opportunity due to extreme heat could impact timing of outdoor athletic events. • Childhood development and older adults are negatively impacted in particular. • While the fittest individuals are likely to find ways to mitigate the risks often by simply shifting their activity to late evening or early morning, for those who are less fit, this may be a reason to avoid physical activity altogether. • Not all sports clubs cancel or alter outdoor programming in heat events (and they may increasingly need to). • Low income tenants in social housing could find themselves even more isolated if low cost/ free outdoor community activities are not able to happen due to increases in high temperature. The health and mental health strain of being isolated from your community can cause issues throughout a family unit. • The high humidex days could also lead to less community gardens, thereby leading to less healthy food availability within small or low income communities.	• New OP policies and Parks and Recreation Master Plan refer to importance of shade in Parks • Recreation, Cultural and Facilities Services (RCFS) has a policy in place to adapt aquatics programs and public swims at all City of Ottawa pools to provide relief when a Heat Alert, Heat Warning or Heat Emergency is declared. • RCFS has a process in place to ensure availability of splash pad locations city-wide for access during heat alerts, heat warnings and heat emergencies. • RCFS has a policy in place to ensure availability and staffing of public beach locations city-wide for access during heat alerts, heat warnings and heat emergencies (limited to July and August due to staffing availability).

4. Increased extreme temperatures and/or high humidex periods may increase the health risks for athletes or active recreation users, especially on surfaces that exacerbate the urban heat island effect.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium-High Risk	High Risk	High Risk	High Risk	Immediate action required.
Community	Medium Vulnerability	High Risk	Very High Risk	Very High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Need to adapt outdoor sporting events (time/duration). Less days of use could increase cost per use to the community, could increase the length of playing season but increase the number of disruptions. • Increased interest in more artificial turf at City facilities since significantly extends use (cost of renewal of a grassed field is over $1 million). Artificial turf, however, requires increased watering and limited use during extreme heat events (less revenue; increased costs). • Increased City liability. • Increasing hours of operation for certain facilities can negatively impact properties that back onto recreational facilities (e.g. noise complaints). • Light pollution from extended hours of fields impacts wildlife (e.g. birds) in urban areas.	• None noted.

5. Increased extreme temperatures and/or high humidex periods may require the provision of more indoor facilities or to add shade to outdoor facilities.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	Medium-High Risk	Develop a plan to address risk.
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Higher operating costs of City facilities. • Potential new projects required to provide more indoor facilities or to add shade to outdoor facilities. • May result in increased use and inadequate space for recreation activities, which would increase the demand for new facilities.	• None noted.

6. Unusually hot temperatures and/or high humidex periods may result in an increase demand for upgrading buildings and facilities.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	High Risk	High Risk	Develop a plan to address risk.
Community	Medium Vulnerability	Medium Risk	Medium-High Risk	Very High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Not all City buildings provide central air. Communities without sufficient recreational facilities will lead to increased strains on health care system. • Residents, especially low-income residents, often look to community centres, libraries and other public buildings as destinations to beat the heat and cool down. When these centres do not offer air conditioning, they are less suitable for other uses, such as indoor recreation opportunities. Residents may be forced to seek out other sources of air conditioning, such as malls	• Staff training • Heat management plans • Investment in capital projects (e.g. AC systems in long-term care facilities)

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
and retail stores, which provide challenges regarding access (i.e., private environments are often 'pay to stay' and if someone is not shopping or making purchases, they may not be welcome). • Community buildings (non-City) may have less ability to respond to higher cooling demands.	

7. Rising temperatures and changing seasons may increase the use of existing parkland and beaches and result in increased environmental damage and degradation from use.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Rising temperatures and extreme heat will require larger parks to have space for trees alongside recreation amenities. This is particularly an issue in the downtown and inner urban areas. • This can result in the overuse of existing parks and environmental damage to trees and amenities. If new parkland is not available, existing facilities will suffer environmental damage. • Parkland dedication has been challenging in recent years. City has relied on National Capital Commission and other federal properties to meet our greenspace requirements.	• A new policy in the Official Plan will prioritize the acquisition of land over cash-in-lieu.

8. Warmer, shorter winters and reduced snowfall may negatively impact winter / outdoor park programming and facilities (e.g., planning, resources, lifecycle costs).

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Develop a plan to address risk.
Community	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Outdoor rinks will be more difficult to maintain. The new Parks and Facilities Master Plan calls for 36 new outdoor rinks by 2031 and possibly three additional outdoor refrigerated rinks. Needs to be equitably distributed. • This will have an impact on facility planning and operations (lifecycle of planning, construction, maintenance etc) as well as programming. For example, Canterbury rink (refrigerated) has required more maintenance, materials, refrigerants, and energy than other non refrigerated community rinks. Will also have a greenhouse gas impacts. • Springtime variability affects opening of sports fields (e.g., from increased rains and freezing rain). This could result in more frequent program/rental cancellations and loss of City revenue.	• None noted.

9. An increase in seasonal temperatures and/or stagnant waters from flooding may lead to intensification of existing disease vectors, and the migration of new disease vectors and illnesses into the community.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Immediate action required.
Community	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	Medium-High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Control programs for wild parsnip, emerald ash borer, poison ivy and ticks place significant pressures on operations due to costs and scale. Strategy is to focus on species that pose health risks and try to manage new invasives before they become established. • The tick *Borrelia burgdorferi* that can carry Lyme disease is now prevalent in Ottawa and has been found on 60% of NCC greenbelt trails. • The City needs to maintain habitat, avoid more habitat fragmentation and be in compliance with species at risk requirements (need parks for both people and ecological assets). • Increased mowing goes against maintaining habitat for species at risk. • Increased resident complaints regarding ticks and mosquitoes. • City is evaluating outdoor program spaces specifically for summer camps. This could result in costly required retrofits or maintenance regimes (e.g., spraying).	• Staff are trained and provided personal protective equipment and bug repellent to reduce the potential for tick bites. • Mosquito control program in west end of city. • Public awareness to parents. • Installing signage at more sites to inform users on how they can mitigate risk of exposure. • Several community groups are active in invasive plant removals (e.g., Rockliffe Park, Ottawa South Comm Association) and Conservation Authorities. • Ottawa Public Health conducts syndromic surveillance of climate-related health conditions including vector-borne diseases such as Lyme disease and West Nile virus.

10. Increased precipitation and other contributing factors (e.g., unmanaged stormwater) may lead to reduced water quality at beaches and natural outdoor swimming areas resulting in conditions that are not favorable to use and reduced recreation and tourism opportunities.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
Community	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Beach closures are due to a combination of nutrient loading from increased stormwater runoff (precipitation issue) and geese droppings (seasonal issue). • Ottawa has few beaches so any closure has a significant impact. No new beaches are planned in the Parks and Recreation Master Plan for the next ten years. • Beach closures have driven up the need for additional cooling opportunities which also impacts recreational programing (e.g., lessons). • More people are swimming in the Rideau River. There may be increased demand for docks and water access, as well as increased pressure to improve water quality.	• Ottawa Public Health gets alerted when there is a hazardous bloom so they can do outreach. Mostly affects lakes and recreational activities. • Mooney's Bay has a recirculation system

Docks require a significant amount of maintenance (e.g., take in and out and beginning and end of season, plus repairs). • There are 14 municipal recreational boat launches and docks in Ottawa, the majority of which are along the Rideau River. While one new recreational boat dock in Riverain Park is planned within the next ten years, the City will consider the development of new seasonal, recreational boat launches and docks along the City's major rivers and tributaries. • Private lakes can be susceptible to algal blooms. Rideau Canal also had a large algal bloom problem recently which impacts boating and fishing (kills small fish and hazards for eating fish). • Some signs of unusual algal growth on Ottawa River (e.g., upstream of Britannia pier).	which helps to circulate the water and reduce the cases of poor water quality.

11. An increase in the volume and intensity of precipitation may result in the flooding of parks, sports fields, and outside event spaces, resulting in park closures and loss of recreational opportunities.

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
Community	Medium Vulnerability	Low Risk	Low Risk	Low Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Parks and recreational areas are prone to saturation. • Parks and recreational facilities in flood-prone areas next to watercourses (e.g., Brewer Park and Arena, Windsor Park, Brantwood Park) are at greater risk. Historical floods to fields, parks, play structures, beaches, resulting in delays to season openings and bookings of parks and sports fields/ball diamonds. • Flooding impacts passive recreation as well as active recreation. • Increased pressure to integrate stormwater management in parks, which reduces their functionality • Increased costs to repair damages	• None noted.

12. An increase in extreme wind and weather events may damage trees, forests, parks and trails leading to damaged public and private property and temporary closures of outdoor public spaces including parks and recreational facilities.

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Historical events (i.e., 2017 & 2019 floods and the tornado) had a big impact on parks operations and parks amenities (e.g., ball diamond tarps torn down; trees falling / damaged in the parks and sport fields and play structures, football posts blown over, equipment damage; closures and delays in amenities opening). • Budget restrictions lead to aging infrastructure and repairs not being completed.	• None noted.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Weather impacts and springtime variability are starting to impact sporting seasons (e.g. trying to get baseball diamonds ready in April and then hit with freezing rain). • Parks and Recreation facilities are often used as emergency shelters during an extreme event which results in changes to existing community programming. • Trees and ecosystems already stressed by drought are more vulnerable. • Clean up of park natural areas (safety concerns).	

13. An increase in extreme weather events, such as high winds, can result in impacts to recreational and shoreline assets.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Natural areas are pretty resilient, but urban areas can require substantial restoration. • City has limited shoreline facilities, but there are risks of damage related costs, i.e. damage to docks, boating, sailing, and dredging of beaches, remediation of break walls, etc. • Shoreline landowners along rivers could experience ice damage to their properties, infrastructure and natural assets. It is not a new impact and many landowners have already adapted.	• None noted.

D.9 Solid Waste

Solid waste includes the collection of waste and operation of facilities to manage garbage, recycling, leaf and yard waste and organic materials. It also includes the management and distribution of biosolid materials. It includes services delivered by the City and contractors.

The following tables include a summary of the noted impacts, vulnerabilities and possible consequences for the Focus Area. Following this table are the impact statements used in the Climate Vulnerability and Risk Assessment (CVRA) along with specific vulnerability / consequence notes and ratings at the City and community scale.

Table D.9 Summary of Focus Area Impacts, Vulnerabilities and Consequences by Climate Hazard Theme

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Extreme Heat, Drought and Humidity 	• Increased health and safety risks to workers • Increased odors • Increased fire risk	• Fires are more likely to be caused by increased moisture in material stockpiles or increased oxygen in an anaerobic environment • People improperly dispose of pool chemicals which can lead to truck fires • Ministry of Labour has halted work during extreme heat events	• Operating adjustments (turning schedules) • Cost to repair infrastructure • Delays to waste collection services if working hours or truck fleet are affected
Seasonal Variability 	• Damaged / compromised solid waste management systems from increased winter freeze-thaw	• Leachate or landfill gas management infrastructure (especially older infrastructure).	• Increased costs to repair and replace infrastructure
Precipitation Volume and Intensity 	• Leachate management / treatment systems can be overwhelmed during high precipitation events • Increased health and safety risks to collection workers (increased weight of wet bags)	• The leachate treatment facility at Trail Road needs replacing • Reduced wastewater treatment capacity at ROPEC could significantly affect disposal of leachate from Trail Road Facility • Precipitation can increase weights for all waste streams on collection days	• Unmanageable leachate could result in a spill to the natural environment with regulatory consequences and environmental impacts • Alternate solutions to treat hauled leachate from Trail Road would result in significant costs

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Extreme Events 	• Damaged / compromised solid waste collection systems • Increased health and safety risks to workers • Increased pressure on waste collection services (e.g. hazardous waste pickup following an extreme event)	• All types of extreme weather (e.g. heat, winter storms) can impede collections • Extreme cold weather events can result in frozen organic waste loads that are hard to unload without thawing • Wind events can disrupt landfills, blow litter into the community and increase risks to staff and equipment	• Reduced worker productivity • Reduced collection capacity • Delayed services • Reallocation of services to affected areas (e.g. flood or tornado site) impacts service to the rest of City

The following table presents a summary of the Solid Waste Focus Area Impact Statements. Details on the ratings for each Impact Statements follows below.

Impact Statement		City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
1.	Changes in seasonal temperatures and duration may increase the spread of invasive noxious weeds and pests resulting in increased health and safety risks to solid waste collection workers.	Low Vulnerability						Low Vulnerability					
2.	Changing winter temperatures and freeze-thaw events in the winter may damage concrete-based solid waste infrastructure, resulting in more frequent repairs and renewals.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.	Low Vulnerability					
3.	Hotter summers may increase the incidence of fires at solid waste collection and management systems resulting in increased health and safety risks to workers and neighboring communities.	High Vulnerability	Low Risk	Low Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.	High Vulnerability	Low Risk	Low Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

	Impact Statement	City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
4.	Hotter summers may increase the incidence of fires at the landfill which could spread to the LFG collection systems resulting in shutdowns to the LFG to Energy systems.	Low Vulnerability						Low Vulnerability					
5.	Increased variations of temperatures during the shoulder seasons and increased precipitation may increase the incidence of landfill odour generation resulting in complaints from neighboring communities.	Low Vulnerability						Low Vulnerability					
6.	An increase in the volume and intensity of precipitation may result in an unmanageable volume of stormwater.	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Develop a plan to address risk.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
7.	An increase in the volume and intensity of precipitation may result in an unmanageable volume of landfill leachate.	High Vulnerability	Low Risk	Low Risk	Low Risk	Medium Risk	Identify possible controls and continue to review for change.	Medium Vulnerability	Low Risk	Low Risk	Low Risk	Medium Risk	Identify possible controls and continue to review for change.
8.	An increase in the volume and intensity of precipitation may increase the weight of yard waste going to organics resulting in health and safety risks to solid waste collection workers.	Low Vulnerability						Low Vulnerability					
9.	Increased variability in temperature and precipitation, including freezing rain, during the shoulder seasons may increase landfill site	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to	Low Vulnerability					

Impact Statement		City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
	management to reduce the risk of subsidence and slope instability.						review for change.						
10.	An increase in wind events may disrupt management of the landfill, blow litter off the landfill site and increase risks to staff and equipment.	Low Vulnerability						Low Vulnerability					
11.	An increase in multi-day ice storm events may lead to power outages and impact solid waste collection and management systems.	Low Vulnerability						Low Vulnerability					
12.	An increase in extreme heat and other extreme weather events can result in increased health and safety risks to solid waste collection and management workers.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.	Medium Vulnerability	Low Risk	Low Risk	Low Risk	Medium Risk	Identify possible controls and continue to review for change.
13.	An increase in more extreme weather events can result in increased pressure on solid waste collection and management resulting in a delay of services.	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Develop a plan to address risk.	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Develop a plan to address risk.

1. **Changes in seasonal temperatures and duration may increase the spread of invasive noxious weeds and pests resulting in increased health and safety risks to solid waste collection workers.**

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Have had incidents of workers coming in contact with wild parsnips. • External collection contractors' perception of risk is missing from the assessment.	• Staff are trained and provided personal protective equipment and bug repellent to reduce the potential for tick bites.

2. **Changing winter temperatures and freeze-thaw events in the winter may damage concrete-based solid waste infrastructure, resulting in more frequent repairs and renewals.**

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Biggest risk is pre-treatment system – since past end of life (shearing is less of an issue) • Medium vulnerability rating is because the facility is old and more suspectable. • This may be an issue with private landfills. This is an unknown.	• The City has plans to build a full-scale leachate management solution.

3. **Hotter summers may increase the incidence of fires at solid waste collection and management systems resulting in increased health and safety risks to workers and neighboring communities.**

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	High Vulnerability	Low Risk	Low Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
Community	High Vulnerability	Low Risk	Low Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Historical fires at tipping face and material stockpile (leaf and yard material or Auto Shredder Residual); some burned for several days. • Increased burden on fire department • Surface fires may be a bit more of a concern • Fires with composting leaf and yard waste have occurred at Trail Waste Facility (TWF), largely due to climatic conditions (moisture) and turning schedule. All regulations are followed to prevent fires. • Incidence of fires are more likely to be caused by increased moisture in material stockpiles or increased windspeed introducing oxygen into an anaerobic environment • Fires in solid waste tend to be from feedstock not the weather. Processors take precautions to actively monitor feedstock. • People improperly dispose of their pool chemicals in waste, which can lead to truck fires. • This may be an issue with private landfills. This is an unknown.	• Intact training for Solid Waste and Fire Services staff, planning, and procedural updates such as Fire Plan. • Adjusted operational procedures on temperature monitoring, storage times on stockpiles, etc. • Landfill equipment, such as compactors, are all outfitted with fire suppression systems. • Ensuring adequate daily cover is used (prevents oxygen from penetrating the waste mound).

4. Hotter summers may increase the incidence of fires at the landfill which could spread to the LFG collection systems resulting in shutdowns to the LFG to Energy systems.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Fires typically occur when some flammable material comes into the tipping face which is not near the Landfill gas (LFG) collection system. • Very low probability of a sub-surface fire near LFG collection system • LFG collection is present at the City owned and operated Trail Waste Facility. • This may be an issue with private landfills. This is an unknown.	• All landfill equipment is outfitted with specialized fire suppression systems and Solid Waste and Ottawa Fire work together to ensure fires are responded to promptly and appropriately. • Intact training for SWS and OFS, planning, and procedural updates such as Fire Plan • Updated procedures, techniques, technology (temperature and CO2 is monitored in Landfill Gas wells), training, etc.

5. Increased variations of temperatures during the shoulder seasons and increased precipitation may increase the incidence of landfill odour generation resulting in complaints from neighboring communities.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Odour generation is based on temperature inversions, winds, moisture levels, permeability of cover, as well as the City's ability to remove landfill gas. • City has not received odour complaints for over 2 years. Stage 5 does not have a planned impermeable cover. As communities build closer to Stage 5 there could be an increase in odour complaints. • There are odour complaints about private landfills (e.g. Navan; anecdotal).	• None noted.

6. An increase in the volume and intensity of precipitation may result in an unmanageable volume of stormwater.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Develop a plan to address risk.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Possible impacts to former landfill sites (e.g., Carp) from increased rainfall. • This may be an issue with private landfills. This is an unknown.	• The City keeps the basins as low as possible before Spring and works with hauling company to prepare (e.g., increased hours of operation to 24/7 to ROPEC) wastewater treatment facility • Final cover installation

7. An increase in the volume and intensity of precipitation may result in an unmanageable volume of landfill leachate.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Low Risk	Low Risk	Low Risk	Medium Risk	Identify possible controls and continue to review for change.
Community	Medium Vulnerability	Low Risk	Low Risk	Low Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• The leachate treatment facility at Trail Road needs replacing. The City has planned to build a full-scale leachate treatment facility since a Class Environmental Assessment in 2005. • Reduced wastewater treatment capacity at ROPEC could significantly affect disposal of leachate from Trail Road Facility • Heavy reliance on trucking off-site; trucking cannot keep up with shipping leachate off-site. Alternate solutions to treat hauled leachate from Trail Road would require significant costs. • Final cover is installed ahead of schedule to reduce leachate impacts and landfill gas generation resulting from extreme rain events. • Stages 3 and 4 have a leachate collection system and the landfill is not set-up to recirculate leachate on site; recirculation can also have negative effects in degrading the liner. • Unmanageable leachate could result in a spill to the natural environment with regulatory consequences and environmental impacts, but it is being mitigated proactively. • This may be an issue with private landfills. This is an unknown.	• The City keeps the basins as low as possible before Spring and works with hauling company to prepare (e.g., increased hours of operation to 24/7 to ROPEC) • Leachate management / treatment analysis is currently underway to improve seep management • Final cover installation

8. An increase in the volume and intensity of precipitation may increase the weight of yard waste going to organics resulting in health and safety risks to solid waste collection workers.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• If Leaf and Yard Waste (LYW) bags get wet on collection day they will be heavier. Precipitation can increase weights for all waste streams but generally impact is low since only occurs on collection days with lots of precipitation. • Higher tonnages tipped at organics facility (Convertus) results in a greater cost to the City. • Weight may help composting efficiency but can result in increased fire risk. • Wet weather helps compact cardboard in the waste collection vehicles. • Most likely to impact collections as increased weight risks health and safety of collection workers as they are picking up additional waste (e.g. leaf and yard waste bags are manually lifted).	• Solid Waste Bylaw has weight limits for LYW bags. Heavy bags are left behind with a tag to explain that the LYW bag is over the allowable amount in the solid waste bylaw • Soldi Waste Services is looking at the possibility of a separate LYW collection from organics collection year round.

9. **Increased variability in temperature and precipitation, including freezing rain, during the shoulder seasons may increase landfill site management to reduce the risk of subsidence and slope instability.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Historical washout conditions / unstable slopes (4:1) during major rain events; likely to worsen when completing final corners of stage 4 and throughout stage 5 (almost all 4:1 slopes) • This may be an issue with private landfills. This is an unknown.	• Seek cover materials that are more resilient to extreme weather to ensure vehicle access is maintained. Use clay type soils for more resiliency on side slopes during wet weather.

10. **An increase in wind events may disrupt management of the landfill, blow litter off the landfill site and increase risks to staff and equipment.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Severe winter windstorm in 2008 blew litter all over Highway 416; resulted in the deployment of emergency crews. • Stage 5 may be at risk due to slopes and proximity to property boundary. • Future wind conditions for collections not a major concern; already dealing with it on a day-to-day basis. • Drier conditions increase risk of blowing dust. • This may be an issue with private landfills. This is an unknown.	• Haul roads are constructed of waste asphalt to increase durability and reduce dust. • Specialized litter fencing is employed – high wind can result in moving the tipping operation to lower elevations. • Use of daily cover changes • The City is researching new litter fencing options (baseball net style may be needed on Stage 5 due to slopes and proximity to property boundary, new landfill cover techniques or technology)

11. **An increase in extreme weather events that lead to power outages may impact solid waste collection and management systems.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Historically a power outage has impacted the operation of the scales at the landfill and creates a backlog of trucks getting into the landfill. • Backup power generation is not a legislated requirement for landfills. • This may be an issue with private landfills. This is an unknown.	• The City installed a back up power system at the Trail Road Landfill

12. An increase in extreme heat and other extreme weather events can result in increased health and safety risks to solid waste collection and management workers.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
Community	Medium Vulnerability	Low Risk	Low Risk	Low Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Hot weather poses risks to all outdoor and indoor workers without access to A/C. Extreme heat could lead to delays in garbage pickup if it is too to safely work. • Waste collectors are also at risk when they collect during heavy rain storm conditions; more storms will be more dangerous for their jobs. • Workplace accidents are known to rise during extreme heat. Delays in pick up can hurt business reputations if garbage is not removed quickly (due to odors).	• There are regulations around working in extreme heat. The Ontario Ministry of Labour has halted work during extreme heat events in the past for short durations. • More frequent breaks would be required for collection staff who are not in the trucks most of the time.

13. An increase in more extreme weather events can result in increased pressure on solid waste collection and management resulting in a delay of services.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Develop a plan to address risk.
Community	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• The City is contractually bound to finish collection by 6 pm every day. It can be very straining on the City's operations as the with increased health and safety risks. • Extreme cold weather events can result in frozen organic waste loads that are hard to unload without thawing. • Collections are impacted by all kinds of flooding that result in excess waste – riverine, stormwater/ heavy rains, and sewage back-ups. • Health and safety issues to workers (e.g. contaminated waste, drywall being mixed into regular garbage). • Reallocation of services impacts the rest of City (i.e. extra costs and resources, service level disruptions, increase call volume, delayed services in other areas). • Increased need for hazardous waste pickup following an extreme weather event. • Could cause delays or added costs to deal with debris from extreme weather events.	• The City has set up additional waste collection and hazardous waste collection in areas affected by extreme weather events.

D.10 Stormwater

The stormwater focus area covers climate impacts to stormwater management and flood protection systems, including constructed infrastructure (storm sewers, culverts, pumping stations, stormwater ponds etc) and natural drainage and stormwater management systems (watercourses, wetlands, etc). The risks are derived from separate Climate Vulnerability and Risk Assessments (CVRAs) that were completed on City owned infrastructure by City staff and their consultants using the PIEVC methodology. Because of the nature of the PIEVC process, non-City owned assets and the impacts on the community are considered as part of the assessment of City services and there may not be separate risk ratings for the Community for some Impact Statements. Furthermore, as the PIEVC assessment focused on asset components of the stormwater system, where possible, the impacts were rolled up to a systems level to align with the city-wide CVRA methodology. Further information can be found in the CVRA for Stormwater Services.

The following tables include a summary of the Focus Area noted impacts, noted vulnerabilities and possible consequences. Following this table are the impact statements used in the CVRA along with specific vulnerability / consequence notes and ratings at the City and community scale.

Table D.10 Summary of Focus Area Impacts, Vulnerabilities and Consequences by Climate Hazard Theme

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Extreme Heat, Drought and Humidity 	• Disruption to natural stormwater systems • Increased risk of wildfires	• Natural stormwater systems such as wetlands, forests, watercourses and stormwater ponds and bioswales • Wildfires can increase sediment and debris in rural and urban watercourses	• Additional maintenance of stormwater facilities (e.g. bioswales, vegetated stormwater ponds) • Degraded water quality, higher temperature flows and impacts on aquatic habitat
Seasonal Variability 	• Disruption to natural stormwater and drainage systems from increased spread of invasive species • Damaged / compromised stormwater and flood protection systems from winter freeze-thaw	• Increased spread of invasive species (e.g. Phragmites) impacting stormwater ponds, bioswales and constructed wetlands. • Increased maintenance of Municipal Drains or roadside ditches • Increased settlement, heave and misalignment of surface or shallow stormwater infrastructure such as catch basins or driveway culverts. • Increased winter maintenance and structural damage to berms, levees and dykes	• Reduced level of service (e.g. reduced water quality, localized flooding) • Additional maintenance of stormwater facilities (e.g. bioswales, ponds) • Increased maintenance of Municipal Drains or roadside ditches. • Increased capital and repair costs

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Precipitation Volume and Intensity 	• Can damage or overwhelm stormwater systems (e.g., ditches, pumping stations, sewers and culverts) • Can result in the overtopping of berms and flood protection infrastructure along the Rideau and Ottawa Rivers • More intense precipitation may lead to increased water flows, erosion and sediment inflow into stormwater systems (e.g. stormwater ponds and watercourses) • Increase in back ups into private dwellings and businesses	• Flooding along the Ottawa River can occur from a range of factors including snowpack, speed of spring melt, and intensity and duration of spring rains • Rideau River and other tributaries are more vulnerable to flooding due to heavy rains (in spring and summer) • Stormwater infrastructure in the floodplain • Berms, pump stations and other flood protection infrastructure along the Rideau and Ottawa Rivers (built to prior standards) • Older areas of Ottawa are more vulnerable to flooding under heavy rains • Undersized / older culverts	• Reduced level of service (overwhelmed minor and major stormwater systems) • Reduced system capacity during major events – particularly multi-day precipitation events • Increased capital and repair costs • Property damage from overland / riverine flooding and basement flooding • Culvert failures and sinkholes • Degraded water quality from sewer overflows • Health and safety, mental and physical health impacts • Financial hardship and displacement of population • Increased demands on pro-active storm drain maintenance and creek and ravine management
Extreme Events 	• Damaged / compromised stormwater systems	• Freezing rain and ice accretion may lead to the clogging of stormwater conveyance systems such as culverts, ditches, catch basins and outfalls. • Increased windborne debris, blockages and clogging of ditches and culverts	• Reduced level of service • Increased capital and repair costs • Reduced water quality • Sewer / Stormwater back up
Global Climate Change 	• Increased material costs • Delayed projects	• Exposure to increased costs, delayed material shipments, unavailability of critical parts for fleet or infrastructure etc.	• Direct impact to the cost of construction materials and activities. • Delayed capital projects resulting in reduced level of service • Higher infrastructure project costs are ultimately borne by the community through higher property taxes and water/sewer rates

The following table presents a summary of the Stormwater Focus Area Impact Statements. Details on the ratings for each Impact Statements follows below.

	Impact Statement	City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
1.	Hotter and drier summers may affect wetlands, forests, watercourses and stormwater ponds, leading to degraded water quality, higher temperature flows and impacts on aquatic habitat, and additional maintenance of vegetation in stormwater facilities.	Medium Vulnerability	Medium Risk	Medium Risk	Medium -High Risk	Medium -High Risk	Develop a plan to address risk.						
2.	Hotter and drier summers can increase the likelihood of wildfires which can damage forests and wetlands and increase sediment and debris in rural and urban creeks.	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Develop a plan to address risk.						
3.	Changes in seasonal temperatures and duration may increase the speed at which invasive species spread (e.g.,. Phragmites), result in damage / disruptions to facilities that have vegetation such as ponds and constructed wetlands.	Low Vulnerability	Medium Risk	Medium Risk	Medium -High Risk	Medium -High Risk	Identify possible controls and continue to review for change.						
4.	More frequent winter freeze thaw cycles could lead to increased settlement, heave and misalignment of surface or shallow stormwater infrastructure such as catch basins or driveway culverts resulting in reduced run off capture, localized flooding, and more frequent repairs and renewals.	High Vulnerability	Medium-High Risk	Medium -High Risk	High Risk	High Risk	Immediate action required.						
5.	Seasonal winter freeze thaw may result in damage to berms, levees and dykes.	High Vulnerability	Medium Risk	Medium Risk	Medium -High Risk	Medium -High Risk	Immediate action required.						
6.	An increase in riverine flooding may damage or overwhelm sewers, ditches, pumping stations and culverts located in the floodplains resulting in localized flooding, basement flooding, erosion and more frequent repairs and renewals.	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium -High Risk	Develop a plan to address risk.						

	Impact Statement	City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
7.	An increase in riverine flooding may overwhelm or damage berms and flood protection infrastructure along the Rideau and Ottawa Rivers resulting in water management issues and downstream impacts.	High Vulnerability	Medium Risk	Medium -High Risk	Medium -High Risk	High Risk	Immediate action required.						
8.	More intense precipitation events may lead to increased water flows, erosion and sediment inflow into stormwater systems, resulting in a reduced level of service, localized flooding, basement flooding and more frequent repairs and renewals.	High Vulnerability	Medium-High Risk	Medium -High Risk	High Risk	Very High Risk	Immediate action required.						
9.	An increase in volume and intensity of precipitation may result in increased stormwater runoff resulting in poor surface water quality and degraded habitat.	High Vulnerability	Medium Risk	Medium Risk	Medium -High Risk	High Risk	Immediate action required.						
10.	An increase in the volume and intensity of precipitation may lead to erosion of riverbanks and ravines and cause bank destabilization, property damage, loss of habitat, and Reduced water quality.	Medium Vulnerability	Medium Risk	Medium Risk	Medium -High Risk	High Risk	Develop a plan to address risk.						
11.	An increase in freezing rain and ice accretion may lead to ice blockages and clogging of stormwater conveyance systems such culverts, resulting in reduced run off capture, localized flooding, and more frequent repairs and renewals.	High Vulnerability	Medium Risk	Medium Risk	Medium -High Risk	High Risk	Develop a plan to address risk.						
12.	An increase in extreme wind events may lead to increased windborne debris, blockages and clogging of ditches and culverts which may result in damaged infrastructure, localized flooding, and more frequent repairs and renewals.	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium -High Risk	Immediate action required.						
13.	An increase in ice storms and other extreme weather may increase multi-day power outages resulting in compromised pump stations and sump pumps, reduced performance, shortened lifespan and increased maintenance.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium -High Risk	Identify possible controls and continue to						

Impact Statement		City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
							review for change.						
14.	Potential failure of electrical systems resulting in reduced performance of stormwater pumping stations or SCADA systems.	Medium Vulnerability	Medium Risk	Medium Risk	Medium -High Risk	Medium -High Risk	Identify possible controls and continue to review for change.						

1. **Hotter and drier summers may affect wetlands, forests, watercourses and stormwater ponds, leading to degraded water quality, higher temperature flows and impacts on aquatic habitat, and additional maintenance of vegetation in stormwater facilities.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	Medium-High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Increased temperature of permanent water volume, reduction in permanent water volume due to evaporation losses, changes in water quality and changes in quantity at headwaters or flushed into watercourses during a rainfall event. • There are not many wetlands that provide quality and quantity control; one example is the Beaver Pond which was adapted to serve as a stormwater anagement pond. • Odor and vegetation loss not expected given tolerance of vegetation in these facilities. • Potential impacts on aquatic biota, potential increased vegetation maintenance, possible damages from debris blockage	• Requirements for vegetated buffers along watercourses • Stormwater Operation and Maintenance Program

2. **Hotter and drier summers can increase the likelihood of wildfires which can damage forests and wetlands and increase sediment and debris in rural and urban creeks.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium Risk	Medium-Risk	Medium-Risk	Medium-Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Impacts on water quality, sediment transport. • Shorter lifespan, loss of shade, loss of property value, loss of evapotranspiration, loss of habitat, loss of carbon sequestration. • Increased operations and maintenance.	• Wildland Fire Risk Assessment to be completed

3. **Changes in seasonal temperatures and duration may increase the speed at which invasive species spread (e.g., Phragmites), resulting in damage / disruptions to facilities that have vegetation such as ponds and constructed wetlands.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	Medium-High Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Changes in seasonal temperatures and duration advantages some species over others (e.g., Phragmites)	• None noted

• Increased spread of invasive species (e.g., Phragmites) could impact stormwater ponds, bioswales and constructed wetlands and result in increased maintenance of Municipal Drains or roadside ditches. • More likely to impact rural areas.	

4. More frequent winter freeze thaw cycles could lead to increased settlement, heave and misalignment of surface or shallow stormwater infrastructure such as catch basins or driveway culverts resulting in reduced run off capture, localized flooding, and more frequent repairs and renewals.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	Medium-High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Ditch-pipe systems, driveway culverts and maintenance hole covers are more vulnerable than deep storm sewers due to their shallower depth. • Can result in increased settlement, heave and misalignment of surface or shallow stormwater infrastructure such as catch basins or driveway culverts.	• Stormwater Operation and Maintenance Program

5. Seasonal winter freeze thaw may result in structural damage and increased maintenance to berms, levees and dykes.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Berms, pump stations and other flood protection infrastructure along the Rideau and Ottawa Rivers (built to former standards)	• None noted.

6. An increase in riverine flooding may damage or overwhelm sewers, ditches, pumping stations and culverts located in the floodplains resulting in localized flooding, basement flooding, erosion and more frequent repairs and renewals.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Stormwater infrastructure in the floodplain is vulnerable (e.g. pump stations, culverts etc.); requires further riverine hazard analysis.	• Berms and other riverine flood control measures

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Rideau River and other tributaries are more vulnerable to flooding due to heavy rains (in spring and summer) • Flooding in the Ottawa River can occur from a range of factors including snowpack, speed of spring melt, and intensity and duration of spring rains	• Floodplain mapping up to 1:350 year flood event • Land use controls . • Stormwater Operation and Maintenance Program

7. An increase in riverine flooding may overwhelm or damage berms and flood protection infrastructure along the Rideau and Ottawa Rivers resulting in water management issues and downstream impacts.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Berms, pump stations and other flood protection infrastructure along the Rideau and Ottawa Rivers (built to former standards); requires further riverine hazard assessment. • Rideau River and other tributaries are more vulnerable to flooding due to heavy rains (in spring and summer) • Flooding in the Ottawa River can occur from a range of factors including snowpack, speed of spring melt, and intensity and duration of spring rains • The City does not control upstream dam operations and maintenance.	• Monitoring, Emergency Preparedness and Response

8. More intense precipitation events may lead to increased water flows, erosion and sediment inflow into stormwater systems, resulting in a reduced level of service, localized flooding, basement flooding and more frequent repairs and renewals.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Older areas of Ottawa are more vulnerable to flooding under heavy rains. • Areas prone to flooding have increased; historical flooding resulted in exposure to septic waste; damage to buildings and mold exposure. • Intensification and zero lot line developments may affect drainage, particularly in the urban core (less permeable surfaces for drainage). With intensification, core building infrastructure may be underground. • Stormwater ponds are typically designed to convey storms up to the 1:100 year events.	• Stormwater Operation and Maintenance Program • Residential protective plumbing, inlet control devices, lifecycle renewal upgrades, foundation disconnections during tear-down rebuilds • Minimum driveway culvert size for new driveway culverts • Sewer Design Guidelines are being updated to consider future climate conditions (also covers stormwater ponds) • The new Official Plan includes new policies on soft landscaping requirements and stormwater management that considers increased imperviousness and future climate conditions

9. An increase in volume and intensity of precipitation may result in increased stormwater runoff resulting in poor surface water quality and degraded habitat.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• More intense precipitation may lead to increased water flows, erosion and sediment inflow into stormwater systems and impact performance levels and water quality. • Increased stormwater runoff (volume and speed) causes extreme variation to water level and flow, making the stream vulnerable to erosion and pollutants (especially at outfalls). This adversely impacts the safety of accessing these streams and can be toxic /detrimental to aquatic species. Could result increased demand for more pro-active storm drain maintenance and creek and ravine management. • Buried / covered streams also significantly impact aquatic ecosystems.	• Stormwater management practices, including Stormwater Management Retrofit Plans •

10. An increase in the volume and intensity of precipitation may lead to erosion of riverbanks and ravines and cause bank destabilization, property damage, loss of habitat, and reduced water quality.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• More intense precipitation may lead to increased water flows, erosion and sediment inflow into stormwater systems and impact performance levels and water quality. Could result in increased demand for more pro-active storm drain maintenance and creek and ravine management. • Historical impacts (Bilberry Creek landslide) resulted in slipping creek / ravine banks and damage to infrastructure (pathways, rinks, light poles, bridge piers, trees). • Mud Creek is also noted to be vulnerable. • There are gaps in terms of the management of creeks and ravines which are also susceptible to climate impacts. • Current storm drain maintenance is reactive. • Shifting slopes with sensitive marine clay (SMC) has resulted in increased tree removals or site reinstatements. • Many properties are built on sensitive clay and could be at risk (hotter and drier in the summer and then saturation in other seasons) • Saturation of clays that might be susceptible to land slides or land flows are a concern from prolonged rain events - also considered an unknown. Retrogressive land slides happen in wet season (e.g. in South Nation watershed) • Could increase conditions where backflow prevention is required. • Increased potential for erosion at outfalls.	• Stormwater management practices, including completing specialized landslide risk studies.

11. An increase in freezing rain and ice accretion may lead to ice blockages and clogging of stormwater conveyance systems such culverts, resulting in reduced run off capture, localized flooding, and more frequent repairs and renewals.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	High Risk	Develop a Plan.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Where bridges, outlet pipes and outfalls are exposed to ice accretion, these assets may be damaged and are harder to repair and restore. Results in increased capital and repair costs. • Ice accumulation in shallow buried infrastructure can result in more water in the system resulting in flooding.	• Stormwater Operation and Maintenance Program

12. An increase in extreme wind events may lead to increased windborne debris, blockages and clogging of ditches and culverts which may result in damaged infrastructure, localized flooding, and more frequent repairs and renewals.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium-High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Wind can result in the increased generation and transport of debris and sediment. • Could result in shorter lifespan, loss of shade, loss of evapotranspiration, and loss of habitat, reduced water quality • Reduced level of service can result in localized flooding. • Increased capital and repair costs.	• Stormwater Operation and Maintenance Program

13. An increase in ice storms and other extreme weather may increase multi-day power outages resulting in compromised pump stations, reduced performance, shortened lifespan and increased maintenance.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Multi-day power outages can result in a significant issue. • Impact could result in reduced level of service, increased capital and repair costs and reduced water quality.	• Most pump stations have back-up power. For pump stations without backup power, operation

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Ice storms and extreme weather can also cause direct damage to stormwater infrastructure.	staff will bring portable generator on-site. • Stormwater operation and maintenance program

14. Potential failure of electrical systems from extreme weather events resulting in reduced performance of stormwater pumping stations or SCADA systems.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	Medium-High Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Possible loss of service	• Most pump stations have back-up power. For pump stations without backup power, operation staff will bring portable generator on-site.

D.11 Transportation

The transportation sector is vulnerable to damage and disruptions from a changing climate and extreme weather. The Transportation Focus Area examined the impacts of climate change on transportation, which included:

- Roads, bridges and tunnels
- Traffic signals and lighting
- Transit - buses, trains, railways, transit corridors, transit stations
- Active transportation – pathways, sidewalks and cycling
- Culverts, ditches and other stormwater infrastructure within rights-of-way
- Street furniture - bus shelters, benches, waste/recycling containers, bike parking, micro-mobility elements

The following tables include a summary of the Focus Area noted impacts, noted vulnerabilities and possible consequences. Following this table are the impact statements used in the Climate Vulnerability and Risk Assessment (CVRA) along with specific vulnerability / consequence notes and ratings at the City and community scale.

Table D.21 Summary of Focus Area Impacts, Vulnerabilities and Consequences by Climate Hazard Theme

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Extreme Heat, Drought and Humidity 	• Decreased use of active transportation systems • Decreased use of public transit systems • Damaged / compromised rail transportation systems • Damaged / compromised road transportation systems	• Asphalt based transportation systems (Transitway) • Steel grating on bridges • Rail systems • Individuals who rely on transit or active transportation for mobility may face health risks or may find it more difficult to make trips	• Decreased asset life and greater repair/renewal rate (e.g. asphalt or steel structures) • Decreased use of public transportation and active transportation could have a negative impact on equity, accessibility and public health if service levels were reduced. • Decreased use of sustainable transportation could lead to increase in private vehicle use, thus increasing GHG emissions, congestion, noise; air quality; and reversing gains made in sustainable modal shares

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Seasonal Variability 	• Damaged / compromised active transportation systems from increased winter freeze-thaw • Damaged / compromised rail and bus transit transportation systems • Damaged / multi-modal transportation systems (thermal cracking, frost heave, potholes, and rutting) • Extended road load restrictions • Health and safety risks to users (slips and falls)	• Hazardous winter sidewalks conditions are a top public concern in the review of maintenance quality standards, with particular impacts on older adults or people with mobility issues • Plowing snow combined with rain and ice causes a big strain on services • De-icing salts are very detrimental to steel structures • Premature deterioration of concrete in bridges and reduced load capacity • Possible unexpected failure of drainage structures due to corrosion • Street furniture (e.g. waste containers, benches) can fail after 2-3 seasons • Limited alternatives to salt since sand provides traction but does not reduce risk to slips and falls.	• Increased maintenance demands and costs • Reduced life of asset, requiring earlier renewal/replacement and increased costs • Accelerated degradation of roads, transit, active transportation and bridge infrastructure from patching activities and freeze thaw / heave of road cuts • Temporary closures of transportation systems (including from watermain breaks) • Increased claims from residents for property and car damage (e.g. from City equipment during winter, or potholes) • Seasonal Load Restrictions could lead to shortened construction seasons and/or higher costs for trucking, and more greenhouse gas emissions (more trips as a result of lighter loads). • Increased slips and falls.
Precipitation Volume and Intensity 	• Damaged / compromised active transportation systems • Damaged / compromised road transportation or transit systems (road washout, bridge failures, landslides affecting roads, bridges, etc.) • Increased health and safety risks to users	• Low lying areas • People who use pathways and roads impacted by floodwaters. • Underground parking garages with inadequate drainage systems • Areas with ditch drainage systems (extreme rain overburdens these systems) • Inter-provincial bridges (Chaudière Crossing closed in 2019)	• Flooded pathways and roads (adjacent to watercourses) • Weakened or washed-out soil resulting in sinkholes • Higher infrastructure maintenance/renewal costs (enlarge sewers and drainage systems, raise road profile grades, address erosion issues) • Washout of roads, culvert collapses and bridges could result in major detours • Reduced access to schools, businesses, essential services, etc.

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Extreme Events 	• Damaged / compromised active transportation system • Damaged / compromised road transportation or transit systems • Increased health and safety risks to users • Electricity or communication interruptions / blackouts • Impacts to traffic signal operations, transit operations, traveler information systems, EV charging, emergency response, etc.	• Public transit reliability can be impacted by extreme conditions (but is an essential service) • More remote, rural properties who may be cut off from roads / utilities • Buried hydro lines help mitigate electricity outages from freezing rain and high winds • Extreme precipitation events bring additional challenges for City fleet and emergency services to operate/reach all areas of the city	• Increased accidents due to road issues • Reduced public safety, road safety, quality of life, equity, and accessibility. • Disruptions to businesses and goods movement • Costly repairs and uncertain timelines • Loss of utility service, including telecommunications service
Global Climate Change 	• Increased material costs (e.g., asphalt) • Delayed projects • Increased cost of energy	• Exposure to increased costs, delayed material shipments, unavailability of critical parts for fleet or infrastructure etc. • Transitioning to non fossil fuel sources will be resource and cost intensive	• Increased costs • Delayed capital projects resulting in reduced level of service • Disruptions to goods movement. • Higher infrastructure project costs are ultimately borne by the community through higher property taxes and water/sewer rates • Increased fuel costs may support accelerated electrification and adoption of renewable energy sources

The following table presents a summary of the Transportation Focus Area Impact Statements. Details on the ratings for each Impact Statements follows below.

	Impact Statement	City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
1.	Hotter summers may lead to extreme heat events and/or reduced air quality and shorten road and infrastructure construction / repair operational windows.	Low Vulnerability						Low Vulnerability					
2.	More extreme seasonal temperatures may result in the decreased use of active transportation and transit systems.	Medium Vulnerability	Medium-High Risk	High Risk	High Risk	High Risk	Immediate action required.	High Vulnerability	Medium-High Risk	High Risk	High Risk	High Risk	Immediate action required.
3.	Hotter summers and UV exposure may deteriorate and buckle rail systems resulting in delays in service, damage to infrastructure, and more frequent repairs and renewals.	Medium Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	Medium-High Risk	Develop a plan to address risk.	Medium Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	Medium-High Risk	Develop a plan to address risk.
4.	Hotter summers and UV exposure may deteriorate asphalt-based surfaces (e.g., rutting from heavy vehicles) and lead to increased damage and more frequent repairs and renewals.	Medium Vulnerability	Medium Risk	Medium Risk	High Risk	High Risk	Develop a plan to address risk.	Low Vulnerability					
5.	Warmer and shorter winters may lead to reduced winter related damage to roads and reduced snow maintenance and removal requirements.	Low Vulnerability						Low Vulnerability					
6.	Shorter winters, longer spring and fall seasons may extend road construction / repair operational windows.	Low Vulnerability						Low Vulnerability					
7.	Shorter winters and longer spring and fall seasons may lead to an increase in demand for active transportation in the spring and fall.	Low Vulnerability						Low Vulnerability					
8.	An increase in variability of winter temperatures and conditions may result in extended road load restrictions and restrict goods and services movement	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Develop a plan to	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Develop a plan to

	Impact Statement	City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
							address risk.						address risk.
9.	An increase in seasonal winter freeze thaw events may increase road salt use which will accelerate corrosion and damage to steel transportation structures (bridges) and street furniture and City vehicles.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Develop a plan to address risk.
10.	An increase in seasonal winter freeze thaw events may increase road salt use and could accelerate the susceptibility / mortality of salt-weakened plants and trees to insects, pathogens and extreme weather.	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Develop a plan to address risk.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
11.	An increase in heavy rains may cause flood-related damage to road infrastructure leading to increased maintenance, reduced asset life and increased risks to users.	Medium Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	High Risk	Develop a plan to address risk.	Medium Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
12.	An increase in the volume and intensity of precipitation may result in increased erosion of riverbanks adjacent to roads which could result in washouts and road closures.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.	Medium Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
13.	An increase in extreme winter weather events and winter freeze thaw events may increase winter maintenance needs and reduce asset life of roads, sidewalks, bridges, etc. thereby decreasing the availability of transportation systems (e.g., reduced	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Immediate action required.	Medium Vulnerability	High Risk	High Risk	Very High Risk	Very High Risk	Immediate action required.

Impact Statement		City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
	transit routes, sidewalk clearing delayed) and increasing the risks to users.												
14.	An increase in multi-day ice storm / extreme wind events may result in damages to communication systems and electricity grids, impacting communication, transportation and emergency systems.	High Vulnerability	Medium Risk	Medium Risk	Medium -High Risk	High Risk	Immediate action required.	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.
15.	Global climate change may cause supply chain instability and/or market failures impacting availability and the cost of fuel, goods, and services.	Medium Vulnerability	Medium Risk	Medium Risk	Medium -High Risk	High Risk	Develop a plan to address risk.	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.

1. **Hotter summers may lead to extreme heat events and/or reduced air quality and shorten road and infrastructure construction / repair operational windows.**

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• For construction, the City tries to work around the times of extreme heat and monitors the weather for possible weather delays. • Labour code allows for increased worker breaks, but there is often not enough time to get to shade and cool down within the allotted breaktime. Service delivery may be impacted if need to shift schedules and provide more breaks.	• Adapting standards, adapting to weather situations in contracting work and associated requirements and expectations

2. **More extreme seasonal temperatures may result in the decreased use of active transportation and transit systems.**

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
Community	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Immediate action required

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Public transit reliability can be impacted by extreme conditions, with greatest impact on poorer populations and other transit-dependent populations. • The City does not yet have programs and/or funding to ensure shaded routes for active transportation (AT). Major challenge to retrofit areas already developed. • Temperature mapping of urban heat islands shows some areas with higher relative temperatures are also neighbourhoods with equity concerns where residents are more likely to depend on AT and transit (e.g. Overbrook, East Industrial-Sheffield Glen-Russell Heights) • Without shaded routes for walking and cycling (including walking and cycling to transit), there could be an increase in morbidity amongst AT users and/or a mode shift away from active transportation. • Decreased use of sustainable transportation would have a negative impact on equity, accessibility and public health. Decreased use in sustainable transportation could lead to increase in private vehicle use, thus increasing greenhouse gas emissions, congestion, noise; reducing air quality; and reversing gains made in sustainable modal shares. • BIAs in some of the City's special districts are installing misting stations or drinking fountains; need trees and shade; black metal furniture doesn't make sense in extreme heat (nice when warm in winter).	• Buses and trains are air conditioned. • Improved bus shelter and transit station design and operational practices, including protected bicycle parking and better end-use facilities for cycling in general (place to change, lockers, etc). • The Official Plan, Climate Change Master Plan and Transportation Master Plan call for significant increases in active transportation (AT) and transit use to achieve goals for GHG emissions reduction, city-building, 15-minute neighbourhoods and public health. • Cross-sections for new roads include requirements for trees • More intentional colocation of shade trees and rest stops areas (benches and bus shelters)

3. **Hotter summers and UV exposure may deteriorate and buckle rail systems resulting in delays in service, damage to infrastructure, and more frequent repairs and renewals.**

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Medium Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	Medium-High Risk	Develop a plan to address risk.
Community	Medium Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	Medium-High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Days with extreme heat (30+ weather) have had impacts on the reliability of rail service; higher future financial need for rail renewal; negative impact on the transit modal share. • Impact on thermocouples. • Transportation system impacts will have a negative effect on residents who rely on public transportation. • The consequence depends on severity and frequency of the impact. Equity, accessibility, and quality of life would be negatively impacted. Access to essential services would be jeopardized. Lost work hours, lost productivity, business disruptions. Could lead to increase in private vehicle use, thus increasing GHG emissions, congestion, noise, and reducing air quality.	• Temporary speed restrictions on all above ground track during extreme heat • Ongoing inspections and maintenance to mitigate rail kinks, including adjusting rail neutral temperature

4. **Hotter summers and UV exposure may deteriorate asphalt-based surfaces (e.g., rutting from heavy vehicles) and lead to increased damage and more frequent repairs and renewals.**

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Medium Vulnerability	Medium Risk	Medium Risk	High Risk	High Risk	Develop a plan to address risk.
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Disruptions and more frequent repair / renewal of roads, bike lanes, sidewalks, transit facilities etc. will negatively affect the services provided to residents; and also have a negative impact on the sustainable mode share. • The City is seeing more structural damages with extreme heat events (e.g. asphalt failure on Transitway (bus routes), steel grating/ sidewalk grating buckling) • More frequent road renewal leads to more traffic impacts, reduction of pavement riding quality for all road users; possible increase in collisions where ponding occurs, increased costs to pay for more rehabilitation • There may also be an increase in public liability - e.g. if there's an asphalt surface failure or a heaved sidewalk panel and bus passenger or pedestrian get injured (happened in Gatineau). • These changes are becoming challenging in terms of what materials can be used, need to ensure that the infrastructure is maintainable in Ottawa's wide range of climate (e.g. salt, winter maintenance)	• Using asphalt materials that are more resistant to temperature fluctuations • Consideration is given to using light colored surfaces to reduce urban heat island effect, reduction of hard surfaces where possible. • More intentional colocation of shade trees and rest stops areas (benches bus shelters)

5. **Warmer and shorter winters may lead to reduced winter related damage to roads and reduced snow maintenance and removal requirements.**

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Less damage to street furniture and fixtures, less need for snow storage leading to more accessible streets, lower costs for snow removal; increased demand for transit and active transportation services. • Positive impact in that there is a reduction of possible winter O&M (low vulnerability rating reflects a low positive impact)	• None Noted

6. **Shorter winters, longer spring and fall seasons may extend road construction / repair operational windows.**

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Longer season is an opportunity to complete some of the finishing ROW work that often gets carried into the next construction season (e.g. tree planting) which can lead to cost and coordination implications. • A longer construction season would place additional pressure on already stretched staff who issue permits; would also result in seasonal staffing issues. • Road maintenance - challenge is that if construction season is pushed further in and there's a big snow event, run the risk of damaging infrastructure (City snow clearing equip can damage materials or infrastructure)	• Adapting standards, adapting to weather situations in contracting work and associated requirements and expectations • Road maintenance quality design standards to be brought forward in 2022

7. **Shorter winters and longer spring and fall seasons may lead to an increase in demand for active transportation in the spring and fall.**

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Low Vulnerability					
Community	Low Vulnerability					

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• May increase the demand for transit and active transportation services (e.g. expand the capacity of the network - addressing missing links, providing new infrastructure, widening of existing infrastructure), but could increase the risk to users (e.g. more potholes). • Impact on transit operations (e.g. change to the design of transit stations to accommodate increases in demand for active transportation amenities). Possible decline in annual transit ridership and revenue.	• Adapting standards, adapting to weather situations in contracting work and associated requirements and expectations. • Make adjustments in planning work.

8. **An increase in variability of winter temperatures and conditions may result in extended road load restrictions and restrict goods and services movement.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Develop a plan to address risk.
Community	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Fluctuation in durations for road load restrictions varies year to year but has not caused issues so far. • Seasonal Load Restrictions (SLR) affect industry, could lead to shortened construction seasons and/or higher costs for trucking during SLR period - costs trickle down to community; more trucks to run at half loads = more greenhouse gases, noise, traffic-induced vibrations • City would take action to address the issue via improved design guidelines and standards, construction practices, materials selection, etc. Otherwise, community impacts would be greater. • Decrease in network connectivity and efficiency in goods movement. • Potentially greater air quality impacts due to less direct truck routing	• A new goods movement strategy, is being developed

9. **An increase in seasonal winter freeze thaw events may increase road salt use which will accelerate corrosion and damage to steel transportation structures (bridges) and street furniture and City vehicles.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
Community	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• De-icing salts are very detrimental to steel structures, significantly reducing their service lives -Increased budget requirements for capital renewals • Possible unexpected failure of drainage structures due to corrosion. • Increased maintenance and renewal costs; reduced lifecycle of asset, requiring renewal/replacement to take place earlier than expected; increased cost of infrastructure renewal • Type and location of street furniture (e.g. waste buckets, benches) matters - can see failure after 2-3 seasons and the cost associated with replacement. Street furniture can also impact on accessibility. • Corrosion of City vehicles • Potential significant economic (financial) damage depending on scale of impact. • Impact of increased salt usage on natural environment and grass in right-of-way.	• Continuous monitoring and maintenance of rail system.

10. An increase in seasonal winter freeze thaw events may increase road salt use and could accelerate the susceptibility / mortality of salt-weakened plants and trees to insects, pathogens and extreme weather.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Develop a plan to address risk.
Community	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Sensitivity about using salt and the surrounding natural environments • Salt is the only effective de-icing product in the City's arsenal right now • A lot of research and investment has already been put into dealing with these events so it would be costly for the City to change practices (e.g., trucks retrofitted to wet the surface before applying salt). • Urban trees are a scarce resource. Many areas with lower tree canopy cover are also disproportionately home to individuals living on lower incomes. The lack of access to green features like trees results in poorer air quality and poorer quality of life, especially for residents without the means or capacity to travel to green locations. Damage of trees by road salt widens this divide, further reducing tree canopy cover, resulting in increased heating during the summer and less protection from excess runoff and flooding. • There are notable increases in salt concentrations in watercourses within Ottawa. This is expected to continue to increase with increased salt usage on roads. Many urban systems do not have adequate buffers to limit runoff. Continued long-term monitoring is required to assess whether systems are approaching toxic levels for aquatic life. • Maintenance costs would increase. Negative impact to road safety, particularly from severe tree damage and broken tree limbs. Negative impact to vegetation, soils, farmland, wetlands, biodiversity and ecosystems. Potential increase in invasive species. Damage to trees and loss of tree canopy would lead to increased temperatures and urban heat island effect, decreased air quality and loss of shade. Impact will be worse in combination with more extreme temperatures.	• Salt Management Plan • Landscaping within the salt spray zone is already quite limited. Where planting occurs close to the curb, trees are considered to be pedestrian amenities with lower life expectancies. • Mitigation measures already include the use of salt tolerant species when planting close to the curb and can further be mitigated through a program of spring flushing, and the use of raised curbs around tree pits to deflect salty drainage away from root balls.

11. **An increase in heavy rains may cause flood-related damage to road infrastructure leading to increased maintenance, reduced asset life and increased risks to users.**

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Medium Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
Community	Medium Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Active transportation (AT) facilities along rivers have been damaged by floods in the past; can result in decreased AT mode share as a result of network gaps/ missing links. • NCC pathways and roads often get flooded resulting in mobility impacts. • Wash-out of small and medium culverts (Ø < 3.0 m) occurs during spring runoff - not solely related to insufficient capacity but also condition (severely rusted inverts, not maintained – e.g., tree branches not cleared, erosion on side of culvert, sediment inside culvert) • Extreme rain events can overburden the rain collection system in rural areas; expect this to increase for road maintenance going forward. • Maintenance of the road drainage system is done reactively, with limited opportunities to identify proactive maintenance • Spring rain combined with high water content in melt creates problems - overwhelms the pipes; runoff from rain / snow combo on agricultural fields; not about volume of snow, but how much water is in snow (snow to water equivalent). • Winter rain is also problematic. Faster and earlier thawing also impacts number of emergency repairs. • Need for more focus on erosion prevention and mitigation measures. • Difficult to quantify the impacts of climate change when it comes to relatively localized decisions • Increased cost for bridges to accommodate larger flow events with climate change • Increased need for 'storm patrols' by staff to identify issues. • Flooding can result in significant costs to existing infrastructure: need to enlarge sewers and drainage systems, raise road profile grades in flood-prone areas, slope and erosion issues • Wash out of roads and bridges could result in major detours and reduced permeability of the network. This may require updates to City standards as well as design practices. For example, may require increased roadway cross slopes also impacting design of active transportation network; some accessibility design features would be impacted as well. • Heavy rains in an urban/suburban area have potential risk for flooding to home owner and sewer surcharging. The City tries to contain water on roads, right-of-way, etc., but runs the risk of residential flooding. • The City often receives calls during heavy rain events looking for sandbags to protect homes.	• All 1-3 m culverts replaced through the planned capital program have a 100-year flow hydrologic/ hydraulic design analysis completed to account for climate change; However, in emergency replacements, the analysis may not be done and the culvert is replaced with something similar in size (future risk) • Sump pumps in rail tunnels

12. An increase in the volume and intensity of precipitation may result in increased erosion of riverbanks adjacent to roads which could result in washouts and road closures.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.
Community	Medium Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• An increased number of emergency road repairs may exceed City capacity (e.g., $10M project to repair riverbank adjacent to Hwy 174 as a result of riverine flooding). City submitted proposal for federal funding. • Inter-provincial bridge closures (Chaudière bridge closed in 2019) • Increased cost for bridges to accommodate larger flow events with climate change • Faster and earlier thawing impacts number of emergency repairs. • Increased reliance on staff to deal with emergencies, flooding can result in significant costs to existing infrastructure: need to enlarge sewers and drainage systems, raise road profile grades in flood-prone areas, slope and erosion issues • Need for more focus on erosion prevention and mitigation measures. • Winter rain is also problematic. • Considering the types of soils present in the Ottawa area, there is a high potential for severe erosion and resulting damage to any adjacent infrastructure. • NCC pathways and roads often get flooded resulting in mobility impacts. • Flooding can affect private lands / assets, damage to buildings, cause need to relocate temporarily or permanently, impacts to property values • Negative impact to multi-modal transportation facilities and access to schools, businesses, essential services and other land uses. Negative impact to accessibility, equity and road safety. Goods movement disruptions would have an economic impact (delays, detours). • Potential negative impact on sustainable mode choice (e.g. cyclists who have to use a longer detour route); impact to modal split is likely temporary. • Environmental risk is typically higher in rural areas (to paved and unpaved roads, shoulders, farmland, soil, trees, vegetation, ditches, wetlands, etc.)	• None noted.

13. An increase in extreme winter weather events and winter freeze-thaw may increase winter maintenance needs and reduce asset life of roads, sidewalks, bridges, etc. thereby decreasing the availability of transportation systems (e.g., reduced transit routes, sidewalk clearing delayed) and increasing the risks to users.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Immediate action required.
Community	Medium Vulnerability	High Risk	High Risk	Very High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Safe sidewalks are one of the biggest issues raised during the City's service review of maintenance quality standards. The public wants better maintenance without using salt. Problematic since sand provides traction but does not reduce risk. • Older adults and people with mobility issues are particularly vulnerable. • The 15 minute neighbourhood relies on the concept of clear, safe streets in the winter in order to increase local sustainable modes of travel. • Plowing snow combined with rain and ice causes a big strain on services. Increased sidewalk damage due to aggressiveness of snow removal to meet public pressure to clear the snow from sidewalks. • Higher maintenance and rehabilitation costs; additional staff, equipment needs to deal with unusual or unpredictable events; increased use of salts • Increase in claims from residents for property and car damage from City equipment • Higher frequency of salting can have negative impacts on infrastructure (e.g. increased salting results in premature deterioration of pavers when in contact with pooling salty road brine), trees and ecosystems. • Increased maintenance, reduced asset life and increased repair and renewal costs from increased winter freeze-thaw (affects roads, sidewalks and paths). • Winter freeze/thaw is more challenging as more salt is deployed during icy conditions which is harsh on neighbouring environments and infrastructure. • Engineering and product advancements will be able to respond to these impacts by adjusting current standards to best practices that are suited to predicted conditions. Some disruption of routine due to temporary closures for repair/renewal work • Negative impact to multi-modal transportation facilities and access to schools, businesses, essential services, etc. Negative impact to accessibility and equity. Negative impact on road safety, particularly to pedestrians. Loss of work hours and productivity and increase in business disruptions. • De-icing salts significantly decreases the service life of structures. Steel structures that convey runoff with high concentrations of salt deteriorate much faster than anticipated.	• Higher frequency of salting and other winter maintenance practices • Using asphalt materials that are more resistant to temperature fluctuations • Improvements in road safety and speed control practices (design, engineering, monitoring, enforcement) to minimize severity of collisions • Recent shift in working patterns to support at-home work may mitigate economic impacts to some extent.

14. An increase in multi-day ice storm events or high winds may result in damages to communication systems and electricity grids, impacting communication, transportation and emergency systems.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Immediate Action Required.
Community	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate Action Required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• While there is some redundancy to deal with isolated power outages, a city-wide power outage would severely impact train service • Impacts to traffic signal operations, transit operations, traveller information systems, EV charging, emergency response, etc. Disruptions to businesses and goods movement. Costly repairs and uncertain timelines. • Negatively impact electric charging stations (for buses and other vehicles). • Buried hydro lines help mitigate power outages from freezing rain and high winds.	• Redundancy in rail power systems (Traction Power substations are fed from two different Hydro Ottawa substations) • O-Train stations have 4 hours back-up power plus generator hook-ups • Rail Operations Emergency Response Working Group to

• Can have significant negative impact on City operations and how well City staff can respond (e.g. recent tornados in Ottawa). • It could be extreme depending on the scale of outages, people no longer able to work, access services, etc. (like in tornado)	review and improve operational emergency preparedness. • Signals is installing backup battery power or providing portable power generation for critical signals.

15. Global climate change may cause supply chain instability and/or market failures impacting availability and the cost of fuel, goods, and services.

Vulnerability & Risk Ratings						
Aspect	**Vulnerability**	**Risk**				**Response**
		Baseline	**2030s**	**2050s**	**2080s**	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	High Risk	Develop a plan to address risk.
Community	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Direct impact to the cost of construction materials (e.g. asphalt) and construction activities. • Increased diesel or power generation costs increases the cost of service. • Increased costs may support electrification or renewable fuels. • Leads to inflation, difficult to budget for; could lead to disruption of all City functions • The supply chain instability would have an impact on construction cost but also on the list of approved products and increased review of alternative products, which may not be to the required standards. • More challenges with procurement (sourcing needed materials) and higher project costs for infrastructure renewal. • Higher infrastructure project costs are ultimately borne by the community through higher property taxes and water/sewer rates.	• Moving towards an electrified bus and train fleet will increase energy security.

D.12 Wastewater

The wastewater focus area covers climate impacts to City wastewater collection and treatment as well as private septic systems. The risks are derived from separate Climate Vulnerability and Risk Assessments (CVRAs) that were completed on City owned infrastructure (collection and treatment) by City staff and their consultants using the PIEVC methodology. Because of the nature of the PIEVC process, non-City owned assets and the impacts on the community are considered as part of the assessment of City services and there may not be separate risk ratings for the Community for some Impact Statements. Furthermore, as the PIEVC assessment focused on asset components of the wastewater system, where possible, the impacts were rolled up to a systems level to align with the city-wide CVRA methodology. Further information can be found in the CVRA for Wastewater Services and for the 2023 Robert O/ Pickard Environmental Centre (ROPEC) Master Plan.

The following tables include a summary of the noted impacts, vulnerabilities and possible consequences for the Focus Area. Following this table are the impact statements used in the CVRA along with specific vulnerability / consequence notes and ratings at the City and community scale.

Table D.3 Summary of Focus Area Impacts, Vulnerabilities and Consequences by Climate Hazard Theme

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Extreme Heat, Drought and Humidity 	• Damaged / compromised wastewater collection and treatment systems • Odor issues from increased fermentation • Damage to wastewater collection infrastructure from increased risk of wildfires	• Increased wastewater temperatures may require increased biological treatment • Extreme temperatures could increase wastewater fermentation in the collection system resulting in increased odors • Electrical systems are vulnerable to prolonged extreme heat (pumping stations, SCADA systems, blowers and cogeneration equipment) • Pump stations and odor control facilities could be exposed to wildfires	• Reduced level of service / reduced wastewater treatment capacity • Increased water treatment / disinfection requirements (capital investment) • Increased capital and repair costs • Reduced wastewater treatment capacity can significantly affect disposal of leachate from Trail Road Facility
Seasonal Variability 	• Damaged / compromised wastewater collection systems	• Increased settlement, heave, and misalignment of surface wastewater infrastructure such as maintenance holes and pump stations • Lower wastewater temperatures can affect nitrification processes and treatment processes	• Increased inflow and infiltration • Reduced level of service (wastewater treatment capacity) • Increased capital and repair costs

Climate Hazard	Impacts	Noted Vulnerabilities / Considerations	Possible Consequences
Precipitation Volume and Intensity 	• Damaged / compromised wastewater systems/ critical infrastructure assets • Damaged / compromised buildings	• Precipitation events increase inflow and infiltration into the wastewater collection system and in private septic systems • Extreme riverine events can damage wastewater collection sewers and pumping stations in the floodplain • Extreme riverine flooding can result in surcharge at chlorine contact tank weirs and inadequate capacity at outfalls at ROPEC	• Basement flooding • Health and safety, mental and physical health impacts • Sewage overflows, flooded pump stations and ponding septic systems • Reduced level of service • Increased capital and repair costs • Damage to buildings from overland / riverine flooding and sewer-related damage
Extreme Events 	• Damaged / compromised wastewater collection and treatment systems (critical infrastructure) • Reduced land availability / road accessibility for biosolids haulage/land application • Multi-day electricity or communication interruptions / blackouts	• Multi-day electricity outages can affect pump stations and treatment plants • ROPEC Co-gen project increases resilience of wastewater treatment plant to electricity outages, but diesel stacks remain vulnerable • Reduced land availability/road accessibility for biosolids haulage / land application which would require that biosolids be stored on site (limited capacity)	• Basement flooding • Health and safety, mental and physical health impacts • Sewage overflows, flooded pump stations and ponding septic systems • Reduced level of service • Increased capital and repair costs • Damage to buildings from overland / riverine flooding and sewer-related damage
Global Climate Change 	• Increased material costs • Delayed projects	• Exposure to increased costs, delayed material shipments, unavailability of critical parts for fleet or infrastructure etc.	• Direct impact to the cost of construction materials and activities. • Delayed capital projects resulting in reduced level of service • Higher infrastructure project costs are ultimately borne by the community through higher property taxes and water/sewer rates

The following table presents a summary of the Wastewater Focus Area Impact Statements. Details on the ratings for each Impact Statements follows below.

Impact Statement		City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
1.	Increased frequency and duration of extreme temperature events could increase wastewater fermentation in the collection system resulting in increased odor problems.	Low Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.						
2.	Increased frequency and duration of extreme temperature events may cause damage to electrical systems resulting in reduced performance of pumping stations or SCADA systems.	Medium Vulnerability	Medium Risk	Medium -High Risk	Medium -High Risk	Medium -High Risk	Develop a plan to address risk.						
3.	Hotter and more humid summers can result in damage and failure of electrical equipment (blowers and cogeneration equipment) resulting in reduced wastewater treatment capacity.	Medium Vulnerability	Medium Risk	Medium -High Risk	Medium -High Risk	Medium -High Risk	Develop a plan to address risk.						
4.	Increased frequency and duration of extreme temperature events may increase wastewater temperature, which may require increased level of nitrification and exceed aeration resulting in reduced wastewater treatment capacity.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.						
5.	Hotter and drier summers may increase the likelihood of wildfires resulting in damage to above ground infrastructure resulting in non-functioning pumps and in-ability to access systems.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.						
6.	More frequent winter freeze thaw cycles or ice accretion could lead to increased settlement, heave, and misalignment of surface wastewater	Medium Vulnerability	Medium-High Risk	Medium	High Risk	High Risk	Immediate action required.						

	Impact Statement	City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
	infrastructure such as maintenance holes and pump stations resulting in increased inflow and infiltration and increased repairs and renewals.			-High Risk									
7.	Increased and more intense precipitation events may lead to increased basement flooding and combined sewer overflows due to increased inflow and infiltration and reduced capacity in the pump station or sewers.	High Vulnerability	Medium-High Risk	Medium -High Risk	Very High Risk	Very High Risk	Immediate action required.						
8.	Increased frequency or severity of riverine flooding may damage wastewater collection sewers and pumping stations in the floodplain resulting in a prolonged inability to meet local conveyance and treatment demands.	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	High Risk	Immediate action required.						
9.	Increased variability in winter temperatures and extreme snow / precipitation events may result in increased wastewater flows and lower wastewater temperatures affecting nitrification processes and treatment processes resulting in reduced wastewater treatment capacity.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.						
10.	Increased and more intense precipitation events may lead to increased inflow and infiltration resulting in reduced wastewater treatment capacity.	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.						
11.	Increased frequency or severity of riverine flooding may damage wastewater treatment systems resulting in a prolonged inability to meet local conveyance and treatment demands	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.						

Impact Statement		City Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)						Community Vulnerability & Risk (Baseline/ 2030s/2050s/2080s)					
		Vulnerability	Baseline	2030s	2050s	2080s	Risk Response	Vulnerability	Baseline	2030s	2050s	2080s	Risk Response
12.	More intense precipitation may damage private septic drain fields, causing increased repairs and renewals and reduced water quality in watercourses or aquifers.							Low Vulnerability	Low Risk	Low Risk	Low Risk	Low Risk	Continue to manage through existing controls and procedures
13.	An increase in ice storms and other extreme weather increase multi-day power outages resulting in compromised pump station and / or treatment plant functionality, reduced overall performance, shortened lifespan and increased maintenance (repair and clean-up).	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium -High Risk	Identify possible controls and continue to review for change.	Medium Vulnerability	Low Risk	Medium Risk	Medium Risk	Medium -High Risk	Identify possible controls and continue to review for change.
14.	An increase in extreme weather events may affect land availability/road accessibility for biosolids haulage/land application.	Medium Vulnerability	Medium Risk	Medium Risk	Medium -High Risk	Medium -High Risk	Develop a plan to address risk.						
15.	Potential failure of electrical systems from extreme weather events resulting in reduced performance of wastewater pumping stations or SCADA systems.	Medium Vulnerability	Medium Risk	Medium Risk	Medium -High Risk	Medium -High Risk	Identify possible controls and continue to review for change.						

1. **Increased frequency and duration of extreme temperature events could increase wastewater fermentation in the collection system resulting in increased odor problems.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Low Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Extreme temperature could increase wastewater fermentation in the system resulting in increased odors. • Sewage temperatures are generally buffered by the ground temperature encasing the piping system. The sewage temperature has a strong correlation with ground temperature.	• Odor control facilities are designed for extreme temperature events to some extent.

2. **Increased frequency and duration of extreme temperature events may cause damage to electrical systems resulting in reduced performance of pumping stations or SCADA systems.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	Medium-High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Warm extreme could have impacts on sanitary pump stations or SCADA systems due to potential failure or underperformed electrical power and electrical equipment. • Some panels installed outside of pump stations for new or old pump stations as well as VFD inside have had issues in 2021 due to extreme heat. • Reduced level of service	• Wastewater Operation and Maintenance Program

3. **Hotter and more humid summers can result in damage and failure of electrical equipment (blowers and cogeneration equipment) resulting in reduced wastewater treatment capacity.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium-High Risk	Medium-High Risk	Medium-High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• The projected increase in heat waves might cause damage to the electrical equipment in buildings or increase stress on the HVAC systems due to increase dehumidification and cooling demand. • The Blower Building is critical because blower failure could affect the plant serviceability for biological treatment. • Failure of cogeneration equipment would increase the electricity consumption from the grid and affect the capability of demand management (therefore increasing operating cost).	• Refer to CVRA and Master Plan for ROPEC wastewater treatment plant.

4. **Increased frequency and duration of extreme temperature events may increase wastewater temperature, which may require increased level of nitrification and exceed aeration resulting in reduced wastewater treatment capacity.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• The projected increase in temperature may increase the wastewater temperature, and accordingly require increased level of nitrification to meet the non-toxic effluent requirement. Currently ROPEC does not have adequate blower capacity to provide nitrification. • The high temperature may result in risk of non-compliance in the future, and major upgrades may be required to provide aeration capacity for nitrification.	• Refer to CVRA and Master Plan for ROPEC wastewater treatment plant.

5. **Hotter and drier summers may increase the likelihood of wildfires resulting in damage to above ground infrastructure resulting in non-functioning pumps and in-ability to access systems.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Would only apply to surface infrastructure adjacent to combustible vegetation, i.e. wastewater pump stations and odor control facilities. • Reduced level of service/ reduced wastewater treatment capacity.	• Wildland Fire Risk Assessment to be completed

6. **More frequent winter freeze thaw cycles or ice accretion could lead to increased settlement, heave, and misalignment of surface wastewater infrastructure such as maintenance holes and pump stations resulting in increased inflow and infiltration and increased repairs and renewals.**

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Increased settlement, heave, and misalignment of surface wastewater infrastructure such as maintenance holes and pump stations • Impact can result in increased inflow and infiltration, reduced level of service (wastewater treatment capacity), increased capital and repair costs.	• Wastewater Operation and Maintenance Program

7. Increased and more intense precipitation events may lead to increased basement flooding and combined sewer overflows due to increased inflow and infiltration and reduced capacity in the pump station or sewers.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium-High Risk	Medium-High Risk	High Risk	Very High Risk	Immediate action required.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Increased inflow and infiltration • Reduced level of service. • Increased capital and repair costs.	• Combined Sewage Storage Tunnel (CSST) provides sewage overflow storage during major rainfall events to reduce the risk of basement flooding for several low-lying lands in the Glebe/O'connor area; it also reduces CSOs and increases operational flexibility and redundancy to major collector sewers. The design of CSST was based on a significant historical event plus 15% to account for increased precipitation. • Sewer separation, retrofits and upgrades, pipe lining, maintenance hole sealing, inlet control devices, sanitary storage facilities, depressed driveway disconnections, foundation drain disconnection, Real Time Control, pump station upgrades, inflow and infiltration reduction program • Residential Protective Plumbing Program • As part of the 2023 Wastewater Master Plan, a climate stress test using Hurricane Frances event will be used to identify vulnerable areas to surface and basement flooding and identify management practices to reduce vulnerability such as inflow and infiltration reduction programs or stormwater management.

8. Increased frequency or severity of riverine flooding may damage wastewater collection sewers and pumping stations in the floodplain resulting in a prolonged inability to meet local conveyance and treatment demands.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	High Vulnerability	Medium Risk	Medium Risk	Medium Risk	High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Wastewater sewers and pump stations near or in river floodplains will be highly vulnerable. Requires further riverine hazard analysis to identify vulnerabilities on certain assets (e.g. individual pump station)	• Sewer separation, retrofits and upgrades, maintenance hole sealing, sanitary storage facilities, CSST, real time control, pump station upgrades

9. Increased variability in winter temperatures and extreme snow / precipitation events may result in increased wastewater flows and lower wastewater temperatures affecting nitrification processes and treatment processes resulting in reduced wastewater treatment capacity.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Snowmelt may result in high peak flow and low temperatures. This may result in high sustained flows of low temperature wastewater. The low temperature may affect nitrification performance, but currently is not required at ROPEC.	• CVRA for wastewater treatment plant, and ROPEC Master Plan.

10. Increased and more intense precipitation events may lead to increased inflow and infiltration resulting in reduced wastewater treatment capacity.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Increased inflow and infiltration into the wastewater collection system	• Sewer separation, retrofits and upgrades, maintenance hole sealing, sanitary storage facilities, Combined Sewage Storage Tunnel (CSST), real time control, pump station upgrades, inflow and infiltration reduction program • Refer to ROPEC Master Plan

11. Increased frequency or severity of riverine flooding may damage wastewater treatment systems resulting in a prolonged inability to meet local conveyance and treatment demands.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Extreme riverine flooding can result in surcharge at chlorine contact tank weirs and inadequate capacity at outfalls at ROPEC. • Reduced level of service • Increased capital and repair costs	• Refer to CVRA for the wastewater treatment plant and ROPEC Master Plan.

12. More intense precipitation may damage private septic drain fields, causing increased repairs and renewals and reduced water quality in watercourses or aquifers.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
Community	Low Vulnerability	Low Risk	Low Risk	Low Risk	Low Risk	Continue to manage through existing controls and procedures.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• The vulnerability is thought to be low for the community but should be monitored. • Precipitation is a very minor component of the hydraulic loading under a leaching bed. The depth to the water table would be more significant.	• None noted.

13. An increase in ice storms and other extreme weather increase multi-day electricity outages resulting in compromised system functionality at ROPEC and wastewater pump stations, reduced overall performance, shortened lifespan and increased maintenance (repair and clean-up).

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium Risk	Medium-High Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Ice accretion, freezing rain, ice storms, and extreme snow can result in power outages and impact wastewater pump stations (system is more vulnerable to multi-day power outages). • The ROPEC Co-gen project increases resilience of wastewater treatment plant to extended power outages, but diesel stacks remain vulnerable.	• The ROPEC Co-gen project. • Most pump stations have back-up power. For pump stations without backup power, operation staff will bring portable generator on-site. • Refer to CVRA and Master Plan for ROPEC wastewater treatment plant

14. An increase in extreme weather events may affect land availability/road accessibility for biosolids haulage/land application.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	Medium-High Risk	Develop a plan to address risk.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• ROPEC currently relies on a contractor to haul the biosolids offsite for beneficial land application. Impacts of extreme weather events on site accessibility could pose significant risk to the current biosolids management strategy, given the limited biosolids storage capacity on site. • If the landfill is overwhelmed, they may not be able to accept the biosolids.	• Refer to CVRA for the wastewater treatment plant and ROPEC Master Plan.

15. Potential failure of electrical systems from extreme weather events resulting in reduced performance of wastewater pumping stations or SCADA systems.

Vulnerability & Risk Ratings						
Aspect	Vulnerability	Risk				Response
		Baseline	2030s	2050s	2080s	
City	Medium Vulnerability	Medium Risk	Medium Risk	Medium-High Risk	Medium-High Risk	Identify possible controls and continue to review for change.

Noted Vulnerabilities and Consequences	Adaptive Responses In Place
• Potential loss of service (e.g. flooded pump station, basement flooding)	• Most pump stations have back-up power. For pump stations without backup power, operation staff will bring portable generator on-site. • Wastewater operation and maintenance program