ADAPTSJ

ACAP SAINT JOHN

NORTH END

NEIGHBOURHOOD CLIMATE CHANGE ADAPTATION PLAN

Neighbourhood Climate Change Adaptation Plan: North End Summary Document

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PREFACE

Climate Change presents Saint John with generational challenges which will require our communities to question their established structures and ways of knowing. Working collaboratively to adapt to Climate Change therefore presents unique and exciting opportunities for the City to not only improve the quality of life for its residents but to build a growing community of resourceful and compassionate global citizens.

In order to become resilient to the effects of Climate Change our community's residents, ecosystems, businesses and systems must be able to survive, adapt and thrive despite the stresses and shocks caused by its impacts. Accomplishing this requires supporting and fostering an environment where residents of Saint John are well-connected to their neighbours and have social support systems in times of stress and shock. It will require physical environments, such as wetlands and urban forests, that help provide shade and passive cooling opportunities in the summer and reduce the impact of extreme cold in the winter. It will require stormwater infrastructure that can handle larger storm events, and it will require water resources which meet the timing and flow demands of humans and natural systems alike. It will require energy systems that can efficiently handle periods of high demand and buildings that rely less on energy sources such as electricity, oil, and natural gas. It will require affordable transportation systems that function throughout extreme weather events, and it will require land use capable of accommodating population shifts due to climate migration.

That is why ACAP Saint John has initiated AdaptSJ, a process where we will investigate, test and implement ways that climate adaptation can help our city meet its basic development needs, build equitable and vibrant neighbourhoods, and become the resilient, thriving community we all know it can be.

ACAP Saint John’s team is committed to providing Saint John with the best available science and social policy, and to integrate the thoughts and ideas of the community, all of which come together to guide our plan forward. Because at its heart, ACAP has always been an environmental incubator, one that transforms and evolves our region’s landscapes with the help of governments, companies and community collaborators. Our work is designed to be seen, felt and experienced throughout the environment – from our wetlands and coastlines to our streets and public spaces.

CLIMATE CHANGE OVERVIEW

1.1 PHYSICAL DIMENSIONS

Climate change is the greatest challenge facing human civilization today. It directly impacts fundamental resources like food, water, and shelter. Weather, or the fluctuating state of the atmosphere characterized by temperature, wind, precipitation, and clouds, is only predictable over hours, days, or weeks. Climate is the average weather or mean variability of these elements over time. Changes in climate can thus be observed over a period ranging from months to thousands or millions of years. The Intergovernmental Panel on Climate Change (IPCC) is a United Nations scientific body and foremost authority on climate change science. In its most recent and Fifth Scientific Assessment Report (AR5), the IPCC finds that warming of the climate system is "unequivocal".

Climate change impacts are already being felt around the world, including warming atmospheres and oceans, diminishing snow and ice cover, and rising sea levels (IPCC, 2014). These changes are a result of a dramatic increase in greenhouse gas (GHG) emissions from human activities that trap heat from the sun in the atmosphere, an effect known as the Greenhouse Effect (Figure 1).

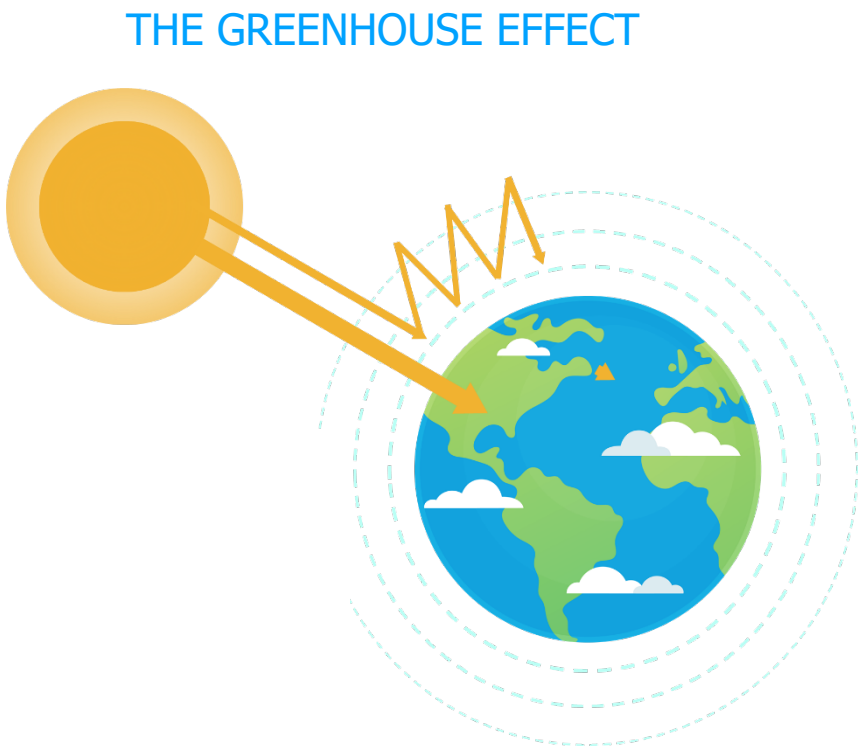

Figure 1: The Greenhouse Effect, where the sun's heat is trapped in the atmosphere by higher quantities of greenhouse gas emissions (Mathematics of Planet Earth, 2012).

Higher concentrations of GHGs in the atmosphere have led to 2016 being the world's hottest year on record (World Meteorological Organization, 2017). This aligns with a trend in global warming that has been observed over the last 60 years (Figure 2).

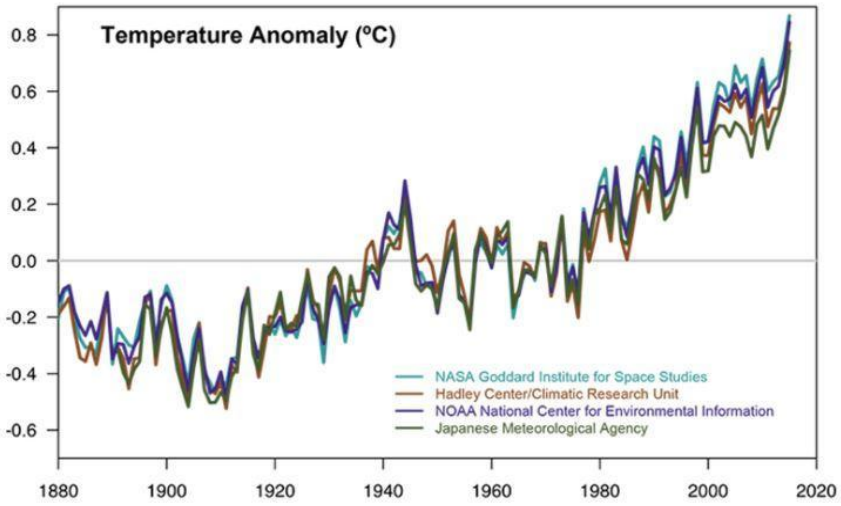

Figure 2: Temperature trends from 1880-2020 (National Aeronautics Space Administration, 2017

In Canada the rate of warming is nearly twice the global average. Temperatures have increased by 1.3 degrees Celsius since 1948 and are projected to hit a 2 degree Celsius rise by 2050 and 4 degree Celsius rise by 2080 (International Council for Local Environmental Initiatives Canada, n.d.). Even with efforts to reduce GHG emissions (mitigation), climate change is already being felt in New Brunswick from rising temperatures, sea level rise, higher intensity precipitation events, increased severity of inland and coastal flooding, accelerated rates of coastal erosion, and land loss that will continue to have negative impacts for the City if no adaptation occurs (NBDELG, 2014). Sea level rise, health risk from extreme heat, flooding, the spread of communicable diseases, urban water quality, and water availability will be the most pressing impacts to the Greater Saint John Area from climate change, requiring local initiative in the coming decades.

Flooding is the most frequent natural disaster in Atlantic Canada. Between 2007-2017 the Government of New Brunswick spent $185 million on disaster recovery primarily from flooding events (NBDELG, 2018). As homeowners' insurance generally does not cover overland flooding, flood protection requires combined responsibility by central government and the private sector to be successful (Vienna University of Technology, 2018). Local governments are linked to climate change issues such as flood protection because of their ability to make planned decisions about key services and infrastructure. Local governments also have the ability to understand flooding vulnerability on a neighbourhood scale, enabling buy-in from the community essential to successful planning implementation.

1.2 ADAPTATION FRAMEWORK

Infrastructure, parks, recreational activity, transportation, and public health and safety are all likely to be affected by climate change. The degree of these changes will depend on global emissions of GHGs over the next three decades, but the impact that climate change will have on our population can be lessened on a municipal scale through adaptation. Adaptation broadly refers to any adjustment that is made to respond to existing or anticipated impacts of climate change on human, natural, or built environments (Natural Resources Canada, 2007). The City of Saint John has a unique opportunity to prepare and respond to these

challenges by identifying the risks of climate change to its natural and built environments, and by taking advantage of the opportunities a changing climate may present.

A central adaptation toolkit, Building Adaptive and Resilient Communities, developed by the International Council for Local Environmental Initiatives (ICLEI-Canada, n.d.) has been implemented by municipalities in British Columbia, Ontario, and Newfoundland. ICLEI-Canada, Partners for Climate Protection and the Federation of Canadian Municipalities are working to guide similar adaptation planning in other Canadian municipalities which consists of five key milestones (Figure 3). This study will address the first three milestones: initiate research and plan and will inform a larger climate change adaptation plan that will apply to the City as a whole, along with the City of Saint John neighbourhood plans.

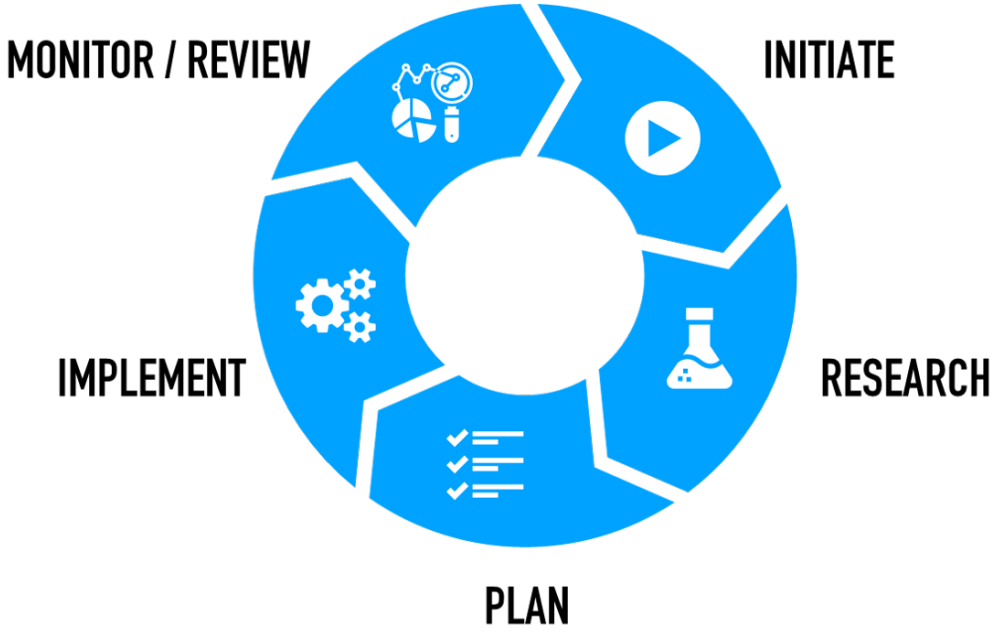

Figure 3: Five key milestones for climate change adaptation beginning with initiate, followed by research, plan, implement and monitor/review (ICLEI-Canada, n.d.).

Adaptation is not without its challenges. The uncertainty of local weather projections means the necessity of addressing climate change is not made obvious until after effects are felt. To protect the public and city assets from its negative impacts, the city-wide climate change adaptation plan uses the precautionary principle, which is to communicate and plan for anticipated climate change impacts based on best available science until cause and effect relationships are fully established scientifically.

Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainability requires thinking about both the short and the long-term costs and benefits of current developments. Cities are complex systems and require holistic thinking to consider all sectors and environments. When dealing with complex systems, no one person can possess all the answers, which is why engaged discussion and a shared vision are vital to planning a sustainable and resilient city.

1.3 OBJECTIVES

Neighbourhood planning is scheduled to take place by the City of Saint John Department of Growth and Community Development Services that will address life in priority neighbourhoods in the City of Saint John. To accompany these plans, ACAP Saint John will study Saint John's three most vulnerable neighbourhoods (Central Peninsula, North End and Lower-West Side) to develop a feasibility plan for adaptation. The study neighbourhoods encompass four of Saint John's priority neighbourhoods where poverty rates exceed 30 % of the population (Plan SJ, 2010). Addressing how climate change will affect impoverished populations is important so adaptation practices do not negatively impact the residents of Saint John.

For each neighbourhood the study will identify vulnerabilities to populations, public health and safety, ecosystems and infrastructure due to climate change risks such as sea level rise, and extreme weather. Based on this information ACAP Saint John will outline recommendations for each neighborhood as they apply to climate change adaptation and neighbourhood planning. For example, using green infrastructure for stormwater management; limiting development in risk areas; or managing our urban forest to maximize ecosystem services. Three pilot projects will be recommended (one in each study neighbourhood) that will demonstrate to the City and to the public how climate change adaptation will look in practice in the City of Saint John.

LOCAL PROJECTIONS

2.1 SUMMARY

CATEGORY	PROJECTIONS
TEMPERATURE	• Mean annual temp. increases by 3.5°C by 2071-2100 compared to 1970-2000. • Average winter temp. above -1°C by 2071-2100. • Up to 70 annual very hot days (25°C +) by 2071-2100. • Annual freeze-thaw days increase from 82 to 87 by 2070.
PRECIPITATION	• Annual rainfall increases by 84.5 mm by 2080 compared to 1976-2005. • Precipitation patterns become more erratic and rainfall intensity will increase by 10 %. • Approximately 20 more days will be rain days by 2071-2100.
EXTREME WEATHER	• Increased severity, frequency of summer convective storms and ice storms. • Increased severity, frequency of flooding from extreme rainfall, mid-winter thaws, ice breakups and ice-jam flooding. • Forest fire occurrence increases by 25 % by 2030, 75-140 % by 2100. • Higher incidence, duration and severity of drought from earlier peak spring flows and very low to zero summer flows.
SEA LEVEL RISE	• Atlantic Canada sea level has risen by ~30 cm between 1911-2000. • Saint John sea level rise of 86 cm +/- 38 cm from 2010 to 2100. • Annual storm surge levels increase by 0.8 m compared to 2010. • 1 in 100-year storm levels increase by 1.3 m by 2100 compared to 2010. • Current coastal erosion rates of 0.59-0.99 m/yr.

Table 1: Climate Change Projections for the Greater Saint John Area (Roy and Huard, 2016; PCC, n.d.; Daigle, 2014)

NEIGHBOURHOOD PROFILE: NORTH END

Portland Place, Douglas Avenue, and the Old North End neighbourhoods comprise the North End. These neighbourhoods lie in a valley with higher terrain north and south of the North End and the land slopes downward toward the Wəlastəkw in the west (Figure 4). Crescent Valley, followed by Rockwood Park, one of the largest municipally owned parks in Canada, borders Portland Place to the north. The Mount Pleasant and Central Peninsula neighbourhoods are located to the east and Millidgeville lies northwest of the North End. The Wəlastəkw bounds the Old North End to the southwest.

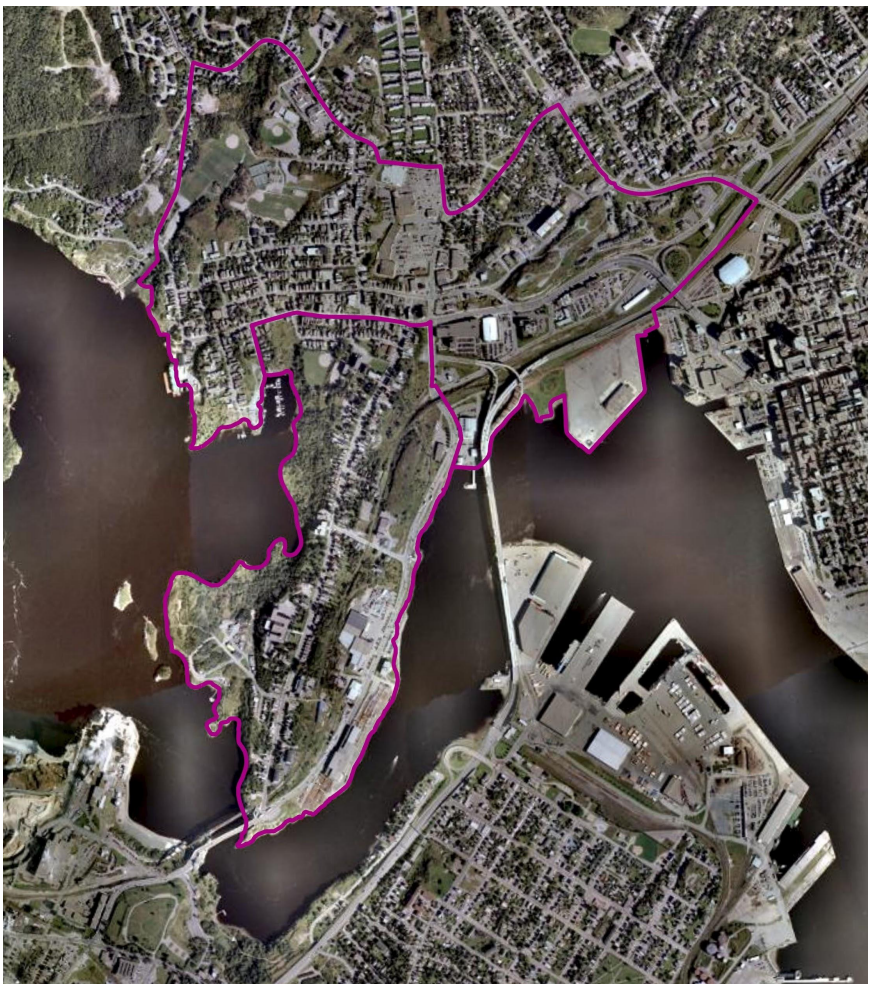

Figure 4: North End neighbourhood boundaries.

The North End is largely residential with commercial strips located along Somerset Street, Lansdowne Avenue, and Main Street. Zoning in the area is comprised of general commercial, mid and high-rise residential, one unit residential, park, and community facility zones. Schools in the area include Centennial School, Divine Mercy Catholic School, and Harbourview High School. Industrial operations in the North End include, Atlantic Towing and OCSO Construction Group (OSCO). OSCO fabricates structural steel and rebar located on Chesley Drive. Atlantic Towing Limited, a marine services port and shop, is located on Bridge Street in the Old North End. The Saint John Power Boat Club is located in Marble Cove, in the Old North End.

Priority neighbourhoods in the area include Crescent Valley and the Old North End and have some of the highest incidences of poverty in the City at 61.6 % and 46.8 %, respectively (Vibrant Communities, 2008). Community Groups in the North End (ONE Change and the Crescent Valley Association) promote health and safety, work to provide affordable housing to community members in need, organize community activities, and promote job readiness. Crescent Valley lies outside of the boundary of the North End neighbourhood but is still considered a priority neighbourhood in the area.

The Old North End is home to many colonial era residences, as this neighbourhood was formerly settled as a trading post with indigenous peoples. Historical portage routes have been recorded in the Old North End and through the Bentley Street Archeological site. The portage route was used by indigenous people to avoid Reversing Falls. Artefacts of stone tools, bowls, and soap have been found at this site and dated to be approximately 4000 years old. The Bentley Street Archeological Site is designated as a Provincial heritage site.

Fort La Tour, part of Harbour Passage, is a grassed archeological site that was formerly part of the Bentley Street portage route, an indigenous burial ground, a French trading post, an English trading post, and a military defence point. The remains of the Fort are buried underground and recognized as a Provincial Heritage Site (New Brunswick Department of Wellness, Culture and Sport, n.d.).

3.1 NEWMAN'S BROOK AND SPAR COVE

Portland Place and a portion of the Old North End are developed within the Newman's Brook Watershed. Newman's Brook flows from Rockwood Park to Hazen White-St. Francis School where it is then piped underground to its outlet at Spar Cove. Spar Cove was infilled in the early 20th century to prevent flooding of nearby homes and is now known as Shamrock Park. ACAP completed the Newman's Brook Watershed Management Plan in 2017 and recommended that Newman's Brook be restored so that it can flow naturally through the North End. ACAP, in partnership with the landowner has been working to restore the mouth of Spar Cove by planting trees along the shoreline and by creating a barrier against vehicle access to curb illegal dumping. Spar cove is commonly used as a lookout for the Wəlastəkw.

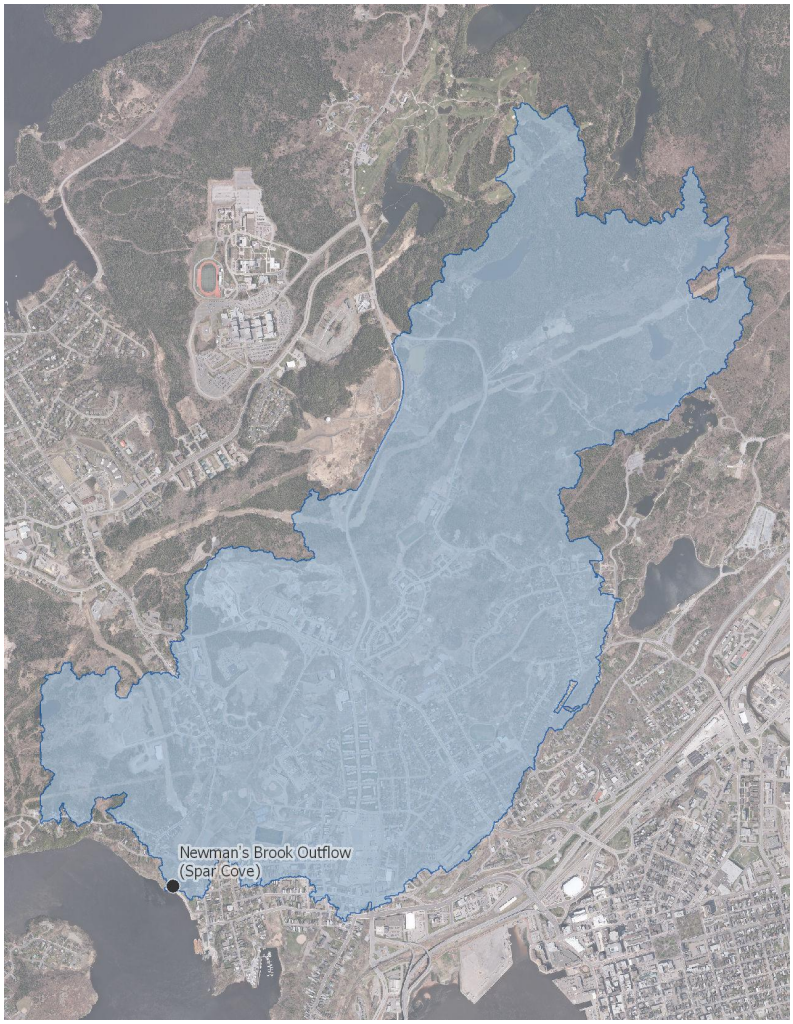

Figure 5: Newman's Brook Watershed Map

As shown in Figure 5, the Newman's Brook watershed extends beyond the boundaries of the North End neighbourhood, therefore, activities outside of the neighbourhood could still impact areas in the North End. This is an important consideration for neighbourhood planning and stands as an example of how our environment does not follow specific political boundaries. Although Newman's Brook is not running at the surface throughout the North End, it is running throughout the sewer system and being discharged into the river at Spar Cove. As such, the overland water flow into the storm sewer becomes a major contributor to the outflow of the brook. For this reason, better stormwater management and community education about these issues is imperative for this watershed.

3.2 PARTRIDGE URBAN PARKS AND FORESTS

Urban parks such as Shamrock Park, Victoria Square, Robertson Square, St. Peters Park, and Riverview Memorial Park are located in the North End. The parks are natural assets that are valuable for recreation, culture, stormwater management, heat moderation, air purification, and carbon dioxide absorption. Many mature trees are located within these parks. Shamrock Park will attract visitors and residents from all areas of the city to its multiple sports fields and recreational trails. Robertson Square provides a recreational area and public access to the Wəlastəkw. Riverview Memorial Park was developed in 1902 to honour veterans of the Boer War. The park is located on Douglas Avenue and overlooks the Wəlastəkw.

3.3 COMMUNITY GARDENS

There are three community gardens run by community groups in the North End that provide fresh produce to participating residents and educational opportunities for growing and maintaining a garden: Crescent Valley Community Garden, Victoria Street Community Garden, and Shamrock Park Community Garden.

RISK AND VULNERABILITY ASSESSMENT

4.1 PRIORITY RISKS AND IMPACTS

Saint John will be impacted by climate change in multiple ways, but in order to effectively plan and adapt to climate change, ACAP Saint John has chosen priority impacts that will have the most pronounced effect on the City. The priority risks of climate change in the coming decades will include 1. sea level rise and storm surges, and 2. severe weather that includes: heavy rainfall, stormwater runoff, early winter thaws that lead to more severe flooding, summer drought, negative health impacts of extreme temperature, and subsequent spread of communicable diseases. These impacts were chosen due to the existing social and environmental challenges in the City compared to local predicted impacts of climate change. The principal purpose of this neighbourhood adaptation plan is to protect the well-being and prosperity of the study neighbourhoods and its residents from these impacts. Each of these impacts will affect the city in different ways. For example, sea level rise will be a major impact in the Central Peninsula and Lower-West Side but will not affect the North End as drastically due to its location in the Harbour and topography.

4.2 PUBLIC ENGAGEMENT

ACAP Saint John used a Draft version of New Brunswick's Coastal Hazard Flood Mapping (CHFM) that is set to be released in 2019 to identify coastal flood risk areas. This set of maps identifies sea level rise and storm surge risks in the future. The maps outline the current Higher High Water Low Tide [HHWLT] (4.6 m), HHWLT+1m (5.6 m) (the average predicted level of sea level rise by 2100), HHWLT+2m (6.6 m) (which models a Saxby Gale like event - post sea level rise), and a 1 in 100 year storm event in 2100 (6.8 m) from the CGVD28 datum based on projections from Daigle's 2017 Report *Sea Level Rise and Flooding Estimates for New Brunswick Coastal Sections* (Figures 6). These maps were used in our risk and vulnerability assessment and during our public information forums and to identify areas at risk from sea level rise and associated impacts.

ACAP Saint John participated in a Sea Level Rise Workshop in August 2018, held by the New Brunswick Environmental Network. The CHFMs were presented to workshop attendees and used to identify coastal infrastructure of importance, areas that are currently being affected by sea level rise, and areas that are at risk of future sea level rise impacts. Five maps were displayed during this workshop. For the purposes of this report, the map from the representative study neighbourhood will be discussed.

ACAP Saint John held two Climate Change Impacts and Adaptation Community Information Sessions in the Fall of 2018. The information sessions were held to inform residents in the study neighbourhoods about the current neighbourhood planning process and adaptation planning that is underway, and to discuss how climate change will affect each community. These sessions also provided opportunities for participants to

provide feedback to ACAP Saint John on information that they felt was important to include in the adaptation plans. The CHFMs were presented in these sessions and residents identified community assets, areas that have already observed climate change impacts and areas that may be at risk of future climate change impacts. The feedback that was collected from all of the community consultation sessions is summarized in Table 2.

Table 2: Community feedback collected during ACAP Saint John's community engagement sessions in 2018.

Category	North End
Community assets	**Recreational/Natural assets:** • Shamrock Park • Lord Beaverbrook Arena **Historical assets:** • St. Peter's Church • Fort La Tour
Areas experiencing climate change impacts	**Floooding Impacts In:** • Shamrock Park • HMS Brunswicker • Pokiok area/Atlantic Towing • Fort La Tour • Coast Guard Port
Areas of importance that may be at risk	• Wooded area, potential fire threat • High deer population, Lyme disease threat • Power boat club, potential flooding risks • Long Wharf, potential flooding risks

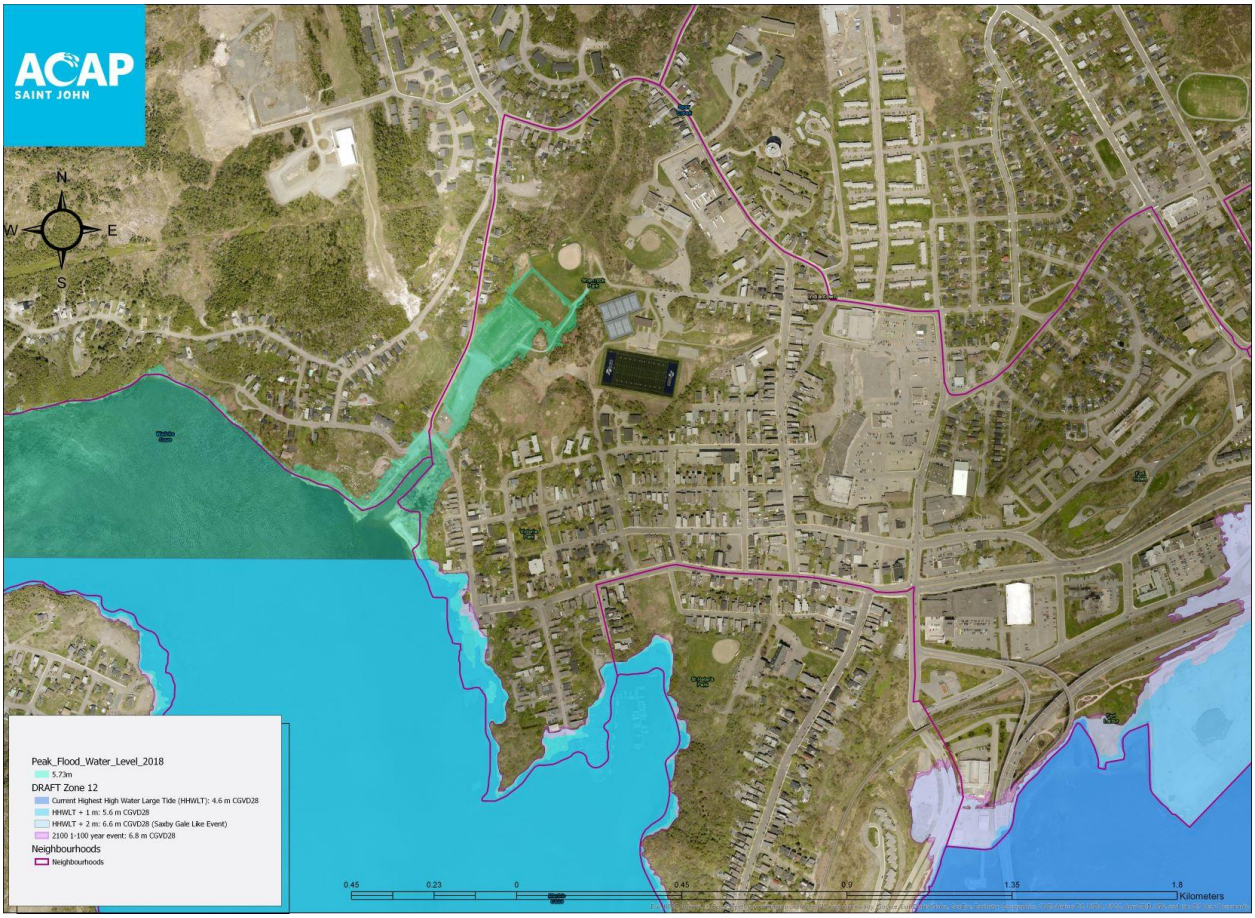

Figure 6: Coastal hazard flood map, North End.

4.3 SEA LEVEL RISE

Based on the CHFMs the City of Saint John's GIS department compared projected sea level rise elevations to current infrastructure, emergency services, population statistics, and ecological parameters to identify risks in the study neighbourhoods. Based on the risks identified in Table 3, ACAP will be able to identify adaptation actions will address these risks.

Table 3: Sea level rise risk areas in the North End.

CATEGORY	Current conditions: Sea Level Rise HHWLT (4.6m) Risks (Highly Probable in 2010)	Sea Level Rise HHWLT + 1 m (5.6m) Risk Events (1-2 % probability in 2010, 20-50 % probability in 2050, 50-100 % probability in 2100.	Sea Level Rise HHWLT+2m (6.6m) Risks (5-10 % possibility in 2100).	Worst Case Scenario: Sea Level Rise 2100 1-100 (6.8m) Risks (1 % possibility in 2100).
EVACUATION CONTROL POINTS	No areas affected	No areas affected	2 control points affected	Two control points affected
EVACUATION ROUTES	Damage to infrastructure, isolation of populations (safety, food security). 3 routes affected by flooding (approximately 731 m)	Damage to infrastructure, isolation of populations (safety, food security). 4 routes affected by flooding (approximately 1.3 km)	Damage to infrastructure, isolation of populations (safety, food security). 30 routes affected by flooding (approximately 7.4 km)	Damage to infrastructure, isolation of populations (safety, food security). 30 routes affected by flooding (approximately 7.4 km)
BUILDINGS IMPACTED	Damage to 7 homes or businesses (1,184 m^2)	Damage to 12 homes or businesses (1,538 m^2)	Damage to 21 homes or businesses (6,231 m^2)	Damage to 22 homes or businesses (9,907 m^2)
PROPERTIES IMPACTED	45 properties affected including 10 industrial properties. Combined property values of flooded areas equal $48,480,700.	49 properties affected including 11 industrial properties. Combined property values of flooded areas equal $48,897,100.	64 properties affected including 18 industrial properties. Combined property values of flooded areas	65 properties affected including 18 industrial properties. Combined property values of flooded areas equal $57,710,400.

			equal $57,494,100.	
TOTAL POPULATION AFFECTED	28 % of the total population live in impacted areas	34 % of the total population live in impacted areas	46 % of the total population live in impacted areas	46 % of the total population live in impacted areas
LOW-INCOME POPULATIONS	9 % of people in flood impact areas are considered low-income	12 % of people in flood impact areas are considered low-income	17 % of people in flood impact areas are considered low-income	17 % of people in flood impact areas are considered low-income
SENIOR POPULATIONS	5 % of people in flood impact areas are seniors (65+)	5 % of people in flood impact areas are seniors (65+)	7 % of people in flood impact areas are seniors (65+)	7 % of people in flood impact areas are seniors (65+)
HABITAT-WETLAND	Coastal Squeeze approximately 1.9 ha	Coastal Squeeze approximately 1.9 ha	Coastal Squeeze approximately 1.9 ha	Coastal Squeeze approximately 1.9 ha
HABITAT-FORESTS	Loss of habitat approximately 11.7 ha	Loss of habitat approximately 11.7 ha	Loss of habitat approximately 11.7 ha	Loss of habitat approximately 11.7 ha
PETROLEUM STORAGE SITES	Contamination: 6 sites at risk of flooding	Contamination: 6 sites at risk of flooding	Contamination: 8 sites at risk of flooding	Contamination: 8 sites at risk of flooding

4.4 SEVERE WEATHER

Table 4: Severe Weather Impacts in the North End.

RISK EVENT	CONSEQUENCE
HIGH WINDS	Fairly sheltered by surrounding topography. Some areas along Douglas Avenue are more exposed and could see higher wind impacts.
DROUGHT	Community gardens: Shamrock Park and Victoria Street could be negatively impacted.
TEMPERATURE EXTREMES: VULNERABLE POPULATIONS	Populations that could be negatively affected by extreme heat/cold include seniors (16 % above the age of 65) and low-income individuals (39 %).
TEMPERATURE EXTREMES: VECTOR BORNE DISEASE	Largest amount of forested/ green space at 21 % of the land base. This will increase the risk of coming in contact with ticks.
TEMPERATURE EXTREMES: INVASIVE SPECIES	No urban street tree inventory completed.
INCREASED RAINFALL: INLAND FLOODING	Low lying areas along the former path of Newman's Brook may be at risk after heavy rainfall (Lansdowne Avenue, Shamrock Park).
SPRING FRESHET: INLAND FLOODING	Areas along the Wəlastəkw (Pokiok, Bridge Street) are at risk of riverine floods.
HEAT ISLAND EFFECT	Total green space is approximately 21 %. Urban heat island effect could be an issue due in more developed portion of the North End to a high number of dark surfaces. An urban forest inventory has not been completed in this neighbourhood.

NEIGHBOURHOOD PLAN RECOMMENDATIONS

By 2100 sea level rise in the North End will result in flooding of approximately 30 evacuation routes, 22 buildings and 64 properties, 8 petroleum storage sites, and 46 % of people living in the neighbourhood. While sea level rise is not as severe in the North End compared to the Central Peninsula and the Lower-West Side, other impacts such as inland flooding, severe weather, and an increase in black legged tick populations could negatively impact residents in this neighbourhood.

The North End, bounded by the Wəlastəkw, is not only impacted by sea level rise, but also by riverine flooding during the spring freshet. The spring flood in 2018 (Figure 6) peaked at approximately 5.73 m above sea level (13 cm below the HHWLT+1 m predictive sea level rise flood level). Areas such as Spar Cove, Shamrock Park, Robertson Square, and homes and businesses along Bridge Street and the Saint John Power Boat Club docks were affected by the flooding. Although only a small portion of the North End was impacted during this flood event, it highlighted areas that will be at risk not only due to sea level rise, but as a result of upstream flooding from the Wəlastəkw. Future development should be limited in these flood risk areas. By-laws like the *Flood Risk Area By-Law* should be updated to include risk areas in the North End so that development can be restricted in flood risk areas. Properties that were impacted by the 2018 flood should investigate flood proofing where possible.

The northeastern portion of the North End is low lying, and stormwater from surrounding areas is likely to travel to lower elevations along the former path of Newman's Brook (Figure 7). Due to this topography, areas along Lansdowne Avenue and Shamrock Park may be more at risk of localized flooding during heavy rainfall events. During ACAP Saint John's public consultation for the neighbourhood plans many residents were surprised to learn that Newman's Brook formerly flowed through the North End. Restoring Newman's Brook and improving stormwater management to make up for the loss of this ecosystem service in the North End will reduce localized flooding and stormwater runoff into combined sanitary and storm sewers.

The fecal coliform concentration at the outflow of Newman's Brook in Spar Cove was well above recommended guidelines in 2017, indicating cross-connections between the storm sewer and the sanitary sewer somewhere within the underground section (ACAP, 2017). For these reasons, it is recommended that water quality monitoring be continued at the outflow site and cross-connections be investigated and fixed to improve the water quality. Additionally, ACAP Saint John's Management plan for Newman's Brook included recommendations to:

1. Improve stormwater filtration through rain gardens, bioswales, vegetated buffers, permeable pavement, etc.
2. Educate the community about the watercourse that is running under their streets and homes.
3. Work towards the end goal of daylighting the entire length of Newman's Brook by daylighting small sections as repair/upgrades are needed.

Figure 7: Map of the historic location of Newman's Brook.

Improving groundwater filtration will not only decrease the strain on the combined sewer system, but it will also increase the adaptive capacity of the neighbourhood to an increase in precipitation patterns brought on by climate change. Stormwater Best Management Practices (BMPs) are recommended to be implemented throughout the Newman's Brook Watershed. Stormwater BMPs include:

- Rain barrels
- Rain gardens
- Bioswales
- Porous Pavement
- Increasing vegetated land
- Street cleaning to remove debris and pollutants from storm drains

Residents should be encouraged to use rainwater to water plants, lawns, and wash vehicles through educational or incentive programs.

The final goal for the Newman's Brook watershed is to improve aquatic and riparian habitat throughout the watershed by resurfacing or 'daylighting' the entire length of Newman's Brook, increasing aquatic habitat within the North End of Saint John, improving water quality, and improving flood mitigation. The daylighting of the brook will also reconnect neighbourhoods to the water that is currently running under their streets, providing natural green spaces to these urban environments. Resurfacing this watercourse would be a very large and difficult project and will likely not happen all at once. It would be ideal to consider daylighting sections of the watercourse when upgrades to storm sewer and/or sanitary sewers are being done throughout the watershed to be as cost effective as possible. There are three forms of daylighting:

1. Natural Restoration: returning the stream to its natural state.
2. Architectural Restoration: exposing the stream to the open air but flowing through a constructed channel.
3. Cultural Restoration: informing the public of the stream's presence underground and educating on the importance of reducing pollutants in runoff (Trice, 2017).

Other severe weather impacts in the North End include high winds that could damage utilities and buildings, drought that could reduce food production in community gardens, and higher temperatures that has potential to impact aging and low-income populations. The Emerald Ash Borer has potential to impact trees in this neighbourhood, although population estimates of street trees are not available as ACAP has yet to complete an urban forest inventory in this neighbourhood.

Public education on climate change adaptation will help to encourage residents to prepare for climate change impacts such as sea level rise, severe weather, and an increase in insect populations that could cause illness. If residents are aware of the actions that they can take to reduce their risk, they will be more empowered to implement adaptation on their end. Public education would be beneficial on a city-wide basis, not just on a neighbourhood scale.

PILOT PROJECT

Spar Cove is located at the confluence of the outflow of Newman's Brook and the Wəlastəkw. The current cove is a fraction of the size it once was due to city expansion and infill. The restoration site is along the terminus of the cove and the Wəlastəkw and is an area that has been mostly infilled and deprived of its natural vegetation; leaving it in need of ecological restoration to bring back native riparian species that once colonized this area. The ongoing renaturalization efforts of the area will help increase healthy riparian areas along the river to benefit wildlife, improve water quality, and buffer flood events.

ACAP Saint John completed cleanups, landscaping and tree planting on a portion of this site during the Spring and Summer of 2018.The continued restoration of this site, which was one of the most hard-hit areas of the 2018 Wəlastəkw flooding, will help improve overall biodiversity and wildlife habitat within an urbanized area of Saint John. This restoration will have a large impact on the neighbourhood around this site by providing an area of where the natural riparian area can flourish (Figure 8). The improvements made to the native vegetation at the site will benefit urban wildlife, both aquatic and terrestrial, by providing habitat and food sources. The overall environment in the area and downstream will benefit from improved filtration of water runoff, improved water quality, and better flood mitigation by providing an area for flood water to breach the banks without compromising infrastructure.

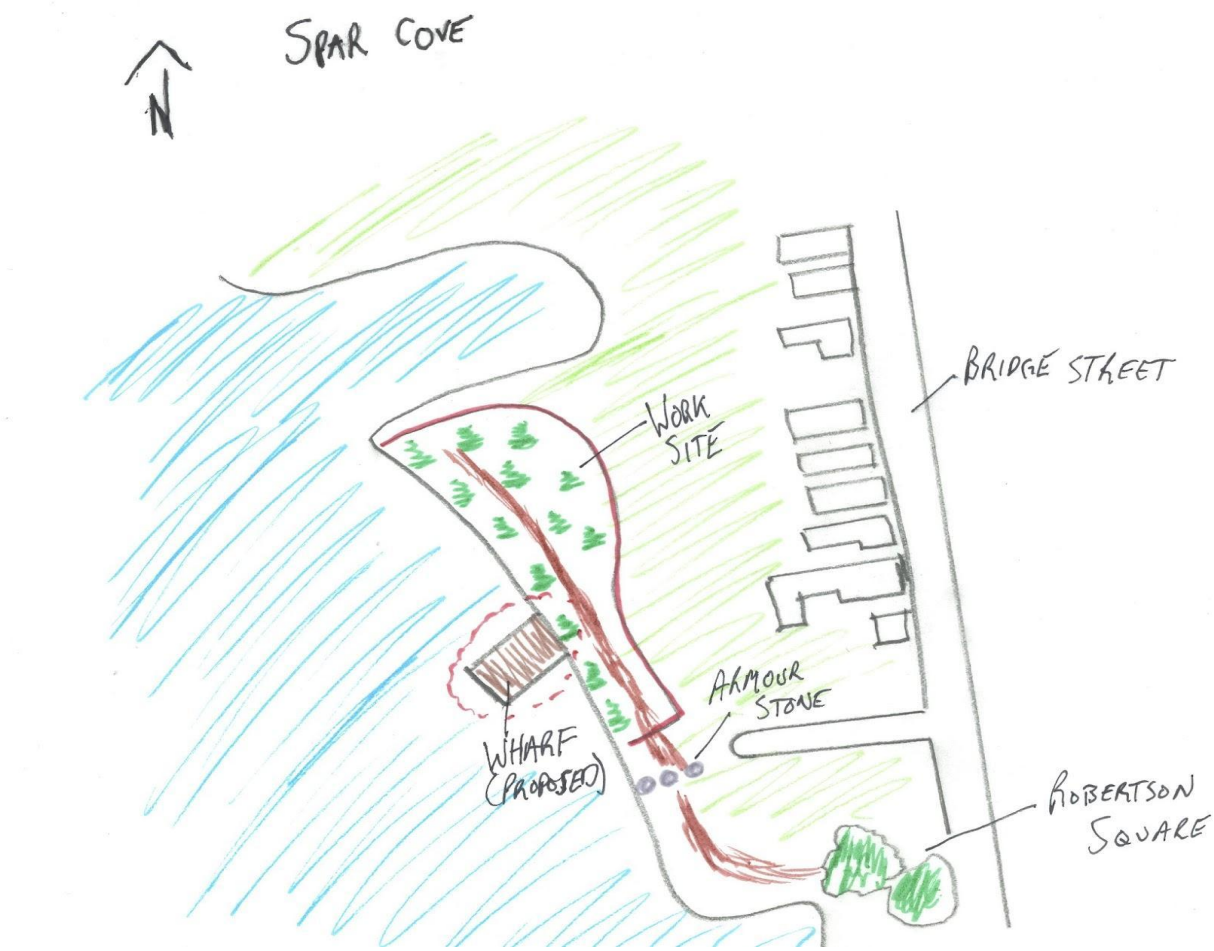

Figure 8: Site plan of a proposed rain garden in Queen's Square West.

The restoration of Spar Cove will also shed light on the area historically for citizens to understand the Newman's Brook watershed. The re-education of the public about Newman's brook will serve as a cultural daylighting exercise that could spur public support for further structural daylighting projects. Educational signage will inform the public of the former path of Newman's Brook, and education on stormwater management in urban areas. This site is already used by residents as a recreational space, so the addition of public amenities such as benches, viewing scopes and a wharf would enhance this space for the public's further enjoyment. In numerous fish monitoring exercises, many species have been observed in the area and could be an excellent site for local fishing.

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