

Traduction française à suivre bientôt

Climate Change Adaptation Plan City of Campbellton



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Your Environmental Trust Fund at Work



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1. Introduction

New Brunswick communities are increasingly susceptible to the effects of sea level rise, storm surge events, and extreme weather events. Increased runoff due to heavy rainfall or frequent winter snow melt as well as freeze-thaw events, erosion of coastlines, and flooding put infrastructure and people at risk. Without contingency plans for such events and the implementation of adaptation measures to mitigate them, some parts of the City of Campbellton are at significant risk. This Adaptation Plan functions as a living document. Not all risks are included in the current plan; the City has decided to focus on sea level rise and inland flooding around the Walker Brook area at this time.



The City of Campbellton. Source: <https://byronchristopher.org/2016/09/11/aerials-campbellton-area-2016/>

The City of Campbellton is located between the Restigouche River and Sugarloaf Mountain, part of the Appalachian Mountain Range, in northeastern New Brunswick (Figure 1). The J.C. Van Horne Bridge connects Campbellton to the province of Quebec. The land area of Campbellton is 18.58 square kilometres and the population density is 370.5 people per square kilometre. Campbellton was incorporated in 1889 and had a population of 6,883 in 2016¹. In 2016, there were 3,120 private dwellings occupied in Campbellton.

Figure 1 - City of Campbellton City Limits



Campbellton achieved City status in 1958 and continues to be the retail and



¹ Statistics Canada, 2016 data (www12.statcan.gc.ca)

service centre for Restigouche County. It is home to schools, a New Brunswick Community College campus, and two hospitals (the Campbellton Regional Hospital and the Restigouche Hospital Center). It is served by Via Rail, regional bus service and taxis. Forestry and tourism are the main industries for the community. Campbellton enjoys the benefits of tourism year-round with sport fishing, canoeing, ski-dooing and skiing. Local attractions include the Restigouche River Experience Centre, the Waterfront Esplanade, Sugarloaf Provincial Park, Kiosk Park, Water Park, and Restigouche Sam, the world's largest salmon monument. Campbellton is the capital of salmon country. Sport fishers travel from around the world to fish in the waters near Campbellton.

Sugarloaf Mountain, Campbellton and the Restigouche River.
Source: <http://www.citytips.com/view/-77460>

The City is located on the traditional and unceded territory of the Mi'kmaq people. The earliest European settlers were of Scottish, English, French, and Irish origins. The original economy of the settlement in the 1700's, was based on fishing and fur trading with the Mi'kmaq and later on saw milling. The City continues to collaborate with Eel River Bar First Nation, located 25 km east of the City, and with Listiguj First Nation as they are directly across the bridge in Quebec. Campbellton is 50/50 French/English and the municipality offers bilingual services.

Campbellton witnesses heavy snowfalls during the winter. The coastal City is somewhat protected from intense wave action due to its upriver location at the mouth of the Restigouche River, but is at risk from storm surges that come up the tidal river. Much of the community is on high ground except for low-lying areas along the waterfront, including the Civic Centre, wastewater treatment plant, recreational venues, the City Centre Mall and a few houses. In 2010, a combination of high tides and strong winds caused flooding in Campbellton. Salmon Boulevard and land near Ramsay Street were flooded.

Walker Brook, which empties into the Restigouche River, is the main river running through the municipality. It has experienced floods due to intense rainfall events causing it to spill over its banks and impact nearby buildings and homes. The watershed of Walker Brook reaches beyond City limits into Atholville.



*Flooding along Salmon Boulevard 2010,
André Bernard*

1.1 How to use this Adaptation Plan

This document presents an assessment of some of the expected climate change impacts, as well as the risks and vulnerabilities of the City to coastal storm surges, erosion and from heavy rainfall or runoff events. While the City also experiences increased freeze-thaw events, those are not explored further here but can be

What is climate change adaptation?

Climate change adaptation is how people adjust to future climate conditions. Adaptation planning involves making adjustments in our decisions, activities, planning, and thinking, because of observed or expected changes in climate. To reduce the risks to the community and take advantage of opportunities, communities need to understand the problems and challenges posed by a changing climate and develop realistic approaches to dealing with them.

added at a later time. In addition, an increasing number of hot summer days may put stress on human health – those impacts need to be assessed in a future iteration of this plan.

This assessment was carried out through an engagement process with City departments, a community planning committee, and with local residents during a public workshop. Information obtained from this process was compiled and summarized, resulting in the identification of 21 sites considered to be most at risk within the City. Site-specific adaptation actions that can be taken to mitigate the risk are described in Appendix # 6.

The adaptation plan is meant to be a living document, as the impacts of climate change will vary over time and will produce diverse hazards, from increased coastal flooding to severe and heavy rainfall events, as well as increased freeze-thaw events in winter and heat waves and drought in the summer. The goal of this adaptation plan is to increase the City's overall resilience and to reduce the risks associated with climate change. It addresses coastal sea level rise, storm surge risk, erosion risk, and, in an initial assessment, inland flood risk. Those were identified as priority hazards by the City.

2. Changing Climate in New Brunswick

Climate change refers to variations in the "average weather patterns" that occur over time. The concentration of greenhouse gases (GHGs) in the Earth's atmosphere is increasing, and increased GHG concentrations are contributing to climate change². The increased GHG concentrations are a result of both natural processes and human activity (mostly related to fossil fuel use), and global temperatures have begun to rise as a result. Not only is the world becoming warmer due to the high levels of greenhouse gases in the atmosphere, global climate change is leading to the increased frequency and severity of weather-related events around the world. Sea levels are rising, ocean currents are shifting, and regional precipitation events are becoming increasingly dramatic and unpredictable³. Global projections from the IPCC⁴ Fifth Assessment Report (AR5) include an upper limit of 0.98 m of global sea-level rise by 2100. This expected rise in sea level increases the need for adaptation in order to minimize damages and costs.

In New Brunswick, coastal sea level rise, erosion, extreme precipitation, inland flooding and increased temperatures are the main hazards associated with climate change. Sea levels around New Brunswick have risen by 24 cm (measured in Saint John) from 1920 to 2015 and coastal erosion rates have been changing.⁵ A rise of coastal waters, along with an increase in storm surges, can accelerate coastal erosion and result in the loss of public infrastructure, such as roads, wharfs and bridges, damage to private property, contaminate sources of drinking water via sea water intrusion, and damage or destroy coastal areas.

Annual flow in rivers is projected to increase for New Brunswick.⁶ In recent years, the Province has seen large fluctuations in river runoff, more frequent winter thaws and an increased risk of ice jams (including mid-winter) and higher April flows.⁷ As a result, washouts, flooding of dwellings, service interruptions, sewage backup in basements, and drinking water contamination are more frequently experienced in New Brunswick. Costs associated with these occurrences are rising. From 2008 to 2012 the estimated total cost of flood-related damage in the province exceeded \$100 million.⁸ However, the 2018 Saint John River flood alone cost over \$80 million; a flooding event that was repeated in 2019.

² New Brunswick Department of Environment and Local Government website.

(http://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/climate_change/content/what_is_climate_change.html)

³ IPCC. 2012 Summary for Policymakers. In: *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 3-21.

⁴ IPCC. Intergovernmental Panel on Climate Change (<http://www.ipcc.ch/>)

⁵ New Brunswick Department of Environment and Local Government website

(http://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/climate_change/content/climate_change_indicators/indicators/water/sea_level.html)

⁶ El-Jabi et al. 2013 in Bush, E. and Lemmen, D.S., editors. 2019. *Canada's Changing Climate Report*, Government of Canada

⁷ Beltaos. 2002 in Bush, E. and Lemmen, D.S., editors. 2019. *Canada's Changing Climate Report*, Government of Canada

⁸ Government of New Brunswick. 2014. *New Brunswick Flood Risk Reduction Strategy*. (www.gnb.ca)

3. Expected Climate Change Impacts for Campbellton

3.1 Sea Level Rise

Sea level is rising due to global thermal expansion of the oceans as well as ice sheets and glaciers melting. Locally, the Campbellton area is also impacted by re-distribution of ice meltwater and vertical land motion. According to Daigle¹², the sea level in the Campbellton region is estimated to rise 63 cm (+/- 19) by 2100⁹ (also see Table 1).



Coastal Flooding along Ramsay Street, 2010, André Bernard

3.2 Increasing Storm Frequency, Intensity and Surge Events

Climate change means that storms will increase in intensity and frequency. Campbellton will see more severe storms year-round, which includes blizzards, windstorms, and resulting storm surges. A variety of processes can contribute to coastal storm surges including atmospheric pressure (increase of 1cm per mb), direct wind effect (onshore or offshore), wave run-up on shore, and rainfall. The timing of high tide will also affect the severity of a surge. In December 2010, Campbellton experienced a severe flood event due to a storm surge with a water level registering at 2.6m. The waterfront, wharves and Salmon Boulevard flooded as did areas to the northeast of Ramsay St.¹⁰ In the future, this type of event will become more common. While it is currently estimated as a 1 in 25-year event, it may become a 1 in 5-year event in 2050.

Various storm surge event scenarios are used for planning purposes (Figure 2). Campbellton is using a 1:100 scenario in 2100. This means a storm that is very strong and rarer, has a 1%



⁹ Real Daigle. 2014. Updated Sea-Level Rise and Flooding Estimates for New Brunswick Coastal Sections. (<https://atlanticadaptation.ca/en/islandora/object/acasa%253A731>)

¹⁰ Government of New Brunswick. 2010. Flood Details. (<https://www.elgogl.gnb.ca/0001/en/Flood/Details/324>)

chance of happening anytime. This storm is predicted to result in a 4.1m flood event (see Figure 3). Storm surges can result not only in flooding but also in increased erosion along the coastline. According to the NB DELG¹¹ the rate of erosion for beaches in Chaleur Bay is 0.32 m/year, dunes 0.35 m/yr, salt marsh 0.17 m/yr and cliffs 0.8 m/yr. Climate change is expected to accelerate these rates.

Flooding along Campbellton's waterfront and Salmon Boulevard in 2010. Source: The Weather Network

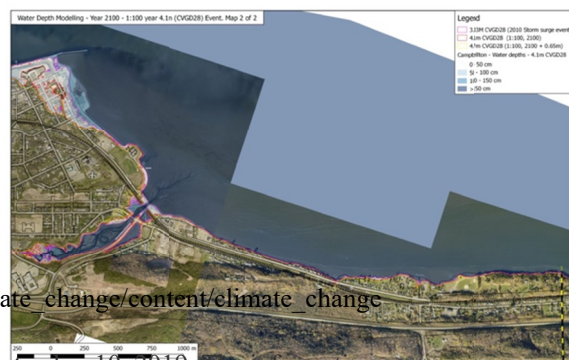
Figure 2 - Sea Level Rise & Storm Surge Flooding Scenarios for the City of Campbellton; HHWLT 1.4 m, ref. CGVD2013¹²

Return Period	Storm Surge	Level 2010	Level 2030	Level 2050	Level 2100	Level 2100 + 0.65 m
1-Year	0.61	2.0 ± 0.1	2.1 ± 0.2	2.2 ± 0.2	2.6 ± 0.5	3.2 ± 0.5
2-Year	0.75	2.1 ± 0.1	2.2 ± 0.2	2.3 ± 0.2	2.7 ± 0.5	3.4 ± 0.5
5-Year	0.94	2.3 ± 0.1	2.4 ± 0.2	2.5 ± 0.2	2.9 ± 0.5	3.6 ± 0.5
10-Year	1.09	2.5 ± 0.1	2.6 ± 0.2	2.7 ± 0.2	3.1 ± 0.5	3.7 ± 0.5
25-Year	1.27	2.6 ± 0.1	2.8 ± 0.2	2.9 ± 0.2	3.2 ± 0.5	3.9 ± 0.5
50-Year	1.42	2.8 ± 0.1	2.9 ± 0.2	3.0 ± 0.2	3.4 ± 0.5	4.0 ± 0.5
100-Year	1.56	3.1 ± 0.1	3.2 ± 0.2	3.3 ± 0.2	3.7 ± 0.5	4.4 ± 0.5

Note: Campbellton Flooding Event, 6 Dec 2010: 2.6 m water level/ maximum surge at Belldune 1.3 m; Source: R.J. Daigle Enviro 2019. Slides presented at a public meeting in Campbellton on September 10, 2019. The information has been updated from Réal Daigle's 2014 report (<https://atlanticadaptation.ca/en/islandora/object/acasa%253A731>)

When the 1:100 scenario is mapped, it provides an overview of the areas along the coastline that are at risk. Figures 3 a) and 3 b) show which areas are impacted, and also provide the depth of flooding for the scenario.

Figure 3 a) & b) - Coastal Flood Risk Map for City of Campbellton



local Government website. [g/environment/content/climate-change/content/climate_change](https://campbellton.ca/g/environment/content/climate-change/content/climate_change) meting in Campbellton on September 10, 2019. The information has been updated from Réal Daigle's 2014 report (<https://atlanticadaptation.ca/en/islandora/object/acasa%253A731>)

3a)

(Larger maps are found [in Appendix # 7](#))

3b)

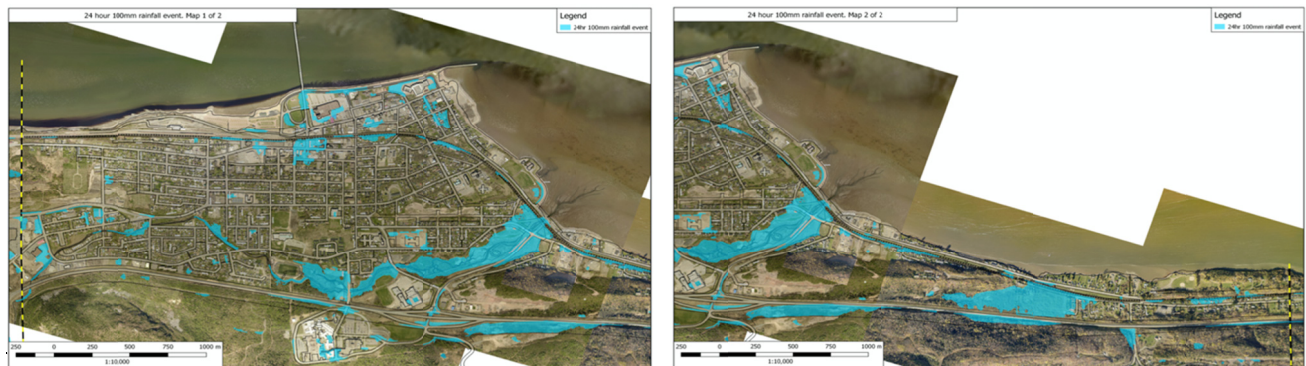
3.3 Increased Precipitation and Inland/Freshwater Flooding

Climate change is impacting precipitation patterns. More precipitation will fall but less often and in more intense events. According to a 2016 Ouranos study¹³ accumulations of rain and snow are expected to increase, especially in the winter and spring. Campbellton must plan not only for coastal flooding but inland or freshwater flooding from increased rain events and snow melt, in particular in the Walker Brook area. Depth to Water Table maps by Dr. Paul Arp (Figures 4 a) and b)) show where freshwater will accumulate in Campbellton. Flood events can result in the erosion of stream banks and roads. Depth to Water Table maps can provide a initial assessment of risk areas, but more detailed modelling is required to properly assess future risk along Walker Brook. With co-funding provided by Canada's National Disaster Mitigation Program (NDMP), the province of New Brunswick is undertaking new flood hazard mapping for New Brunswick inland (riverine) areas. Working closely with the Université de Moncton (U de M), this project will build on work formerly completed by U de M regarding flow modeling at ungauged locations and climate change projections. The final output will be a set of electronic flood hazard maps and a hydrotechnical summary report will also be prepared describing the calculations used to estimate the water levels shown on the maps. The adaptation plan will need to be updated once the new flood modelling is received in 2020.



Freshwater flooding in Campbellton 2009, André Bernard

Figure 4 a) & 4 b) - Depth to Water Table Map for City of Campbellton, projected flooding from a 100mm Rain Event in 24 hrs



Philippe Roy and David Huard. 2016. Future Climate Scenarios Province of New Brunswick. Ouranos

4a)

(Larger maps are found [in Appendix # 8](#))

4b)

3.4 Increased Temperature

The City of Campbellton is expected to experience warmer average annual temperatures in the future. Higher increases will take place in the winter and there will be more hot days (higher than 30°C) in the summer.¹⁴ This will result in an increase in heat waves in the summer, and ice storms, hail and messy weather in the winter. Temperatures in the province have increased by 1.5°C over the last hundred years, and 1.1°C over the last thirty years. Average temperatures have increased in all parts of New Brunswick. Winter temperatures in New Brunswick are expected to warm by 3 to 4°C by 2050 relative to the 1961-1990 period, and winters are expected to become shorter.¹⁵

¹⁴ Phillippe Roy and David Huard. 2016. Future Climate Scenarios Province of New Brunswick. Ouranos

¹⁵ New Brunswick Department of Environment and Local Government website.

(https://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/climate_change/content/climate_change_indicators.html)

4. Previous Studies and Reports

QUEST performed a climate risk and resilience assessment for the City of Campbellton in 2019.¹⁶ The report lists assets at risk as well as community strengths and opportunities for improvement. The report is based on input from a municipal staff survey and stakeholder workshops. Risks identified included the increasing severity and frequency of storms, temperature rise, coastal and inland flooding, forest fires, and impacts on residents from power outages and potential food shortages. Despite the risks, the QUEST report found the community has numerous strengths to deal with climate change, including collaboration with nearby communities, good communication by current mayor and council, and emergency planning. The QUEST report also lists opportunities where resilience could be improved including building stormwater retention ponds, including climate risks in asset management and land use planning, moving important infrastructure out of known flood zones, improving education on resilience in local schools, obtaining backup power for certain vital services, and stockpiling relief supplies. A full list of strengths and opportunities identified by QUEST is listed in Appendix # 1.

Resilience is the ability to respond to change or disruption. This includes understanding potential changes, acting to reduce impacts before, during, and after a disturbance.

The 2019 Chaleur Region Climate Change Adaptation Plan¹⁷ identified similar risks to the QUEST report. Impacts the plan addresses are sea level rise, ice cover reduction and extreme events. The plan found vulnerabilities to include impacts on health and safety, property damage, loss of livelihood and damage to industries, infrastructure, and impacts on socially important locations and buildings. The long-term (10+ years) vision for the Chaleur Region Climate Change Adaptation Plan focuses on safety, preserving aesthetics, protecting sensitive infrastructure, taking advantage of economic opportunities of a changing climate, and, in the long-term, the vision also includes retreating from coastal hazards. Adaptation measures in the plan target education, data acquisition, planning and regulations, protective measures, and emergency planning.

¹⁶ Eddie Oldfield & Julie Bunker. 2019. Climate Risk and Resilience Assessment City of Campbellton. QUEST.

¹⁷ Jean-Philippe Martin & Yann Chavailleaz. 2019. Chaleur RSC Regional Climate Change Adaptation Plan. WSP Canada Inc.

5. Risk and Vulnerability Assessment

Risks associated with sea level rise, storm surges, and inland flooding were chosen as priority risks for the City at this time. Risks and vulnerabilities were determined from previous studies (see above), existing data, maps, consultations with City of Campbellton staff and a public workshop. See Appendix # 2 for a summary of the public workshop. Other risks such as more hot days, freeze-thaw events, and ice storms and associated power outages, need to be considered in future iterations of this plan. The inland flood risk assessment will need to be updated once modelling is available from the province of NB.

5.1 Flooding caused by Sea Level Rise and Storm Surge

Although the City is relatively sheltered due to its location, storm surges have caused significant flooding in the past (such as in 2010, see photos throughout this plan).

The City has decided to use the worst-case scenario of a 1:100 year storm event that would cause a 4.7 m water level (coastal) to assess the vulnerability of its public and private infrastructure. Such a storm could affect a variety of locations. For example, 50-60% of water and sewage infrastructure is 100 years old. In addition, 70% of this infrastructure is still combined, which increases stress on the stormwater management system.

The City has an asset management plan in place and total assets are estimated between \$300 & 400 million. The City also has an Emergency Measures Plan in place that is currently being reviewed internally. The City plans to move the emergency evacuation centre location from the Civic Centre to schools and will be getting a trunk mobile radio (TMR) system.

Risk is a measure of the expected outcome of an uncertain event. The determination of the risk of a climate change impact and stress to the component is based on the economic, health and safety, cultural and historical, and ecological and environmental consequences to the component and the likelihood that the climate change impact will occur. (Source: IPCC report)

The municipal plan will be reviewed and redone within the next 2 years. However, there is a limited budget and lack of capacity at the planning commission to implement and enforce bylaws. As a result of the City being sandwiched between the Restigouche River and Sugarloaf Mountain, there is very little land left to develop on, or to retreat from flood zones. Planners are currently looking to increase density near the downtown core.

5.2 Inland Flood Risk

In addition to coastal flood risk and sea level rise, the City of Campbellton has experienced previous freshwater floods, most notably in 2009 when Walker Brook, the main river running through the City, flooded into nearby neighbourhoods. The Government of New Brunswick is preparing inland/freshwater flood risk modelling, however at the time of writing this plan it was not ready yet. For now, Dr. Paul Arp's Depth to Water Table modelling is included in this report. Figures 4 a) and b) show the potential impact of a 100mm rain event within 24 hrs. When provincial inland flood risk modelling is complete the Campbellton Adaptation Plan should be updated to include the newer, and more exact data.

5.3 At Risk Locations

The City of Campbellton identified 21 sites which are at risk from flooding (Figures 5 a) and b)). They are categorized into high, medium and low risk. Sites categorized as high risk could see significant disruption and/or damage happening repeatedly which could have a long-term impact and the potential of causing extensive damage. High risks sites may require significant emergency response, and repair costs will be significant. Medium risk sites may see some disruption in services and operations, moderate effects, moderate repair costs, temporary displacements and may have some broader impacts. Low risk sites are areas that may see little disruption or very localized damage, minimal effects on operations and/or functioning, minimal effects on citizens, and repair costs are expected to be low.

Sites that are projected to be highly impacted and are therefore of the highest concern include Ramsay Street (site #6 Figure 5, Appendix # 9), where the road may become impassable and basements could flood with a storm surge. The City Centre Mall (# 17) is at high risk for coastal flooding. The Mall houses many private and public lessees, including provincial courts. The building has already flooded in the past during high tides and has an underground pumping station. The building is located on reclaimed ground.

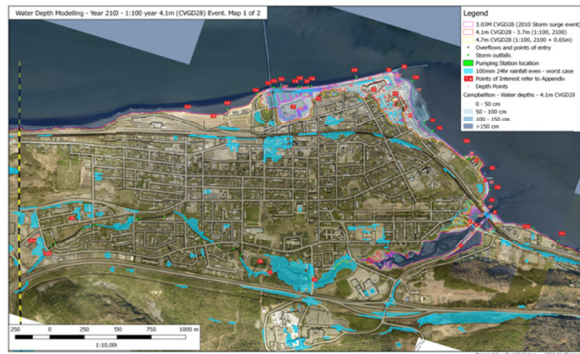
The low-income Sister Green housing area (# 19) near Walker Brook could flood during a heavy rainfall event but is at a high enough elevation that it would not be impacted by a coastal storm surge. Areas along Walker-Brook (# 21) are listed as medium to high risk due to past and potential future freshwater rain events leading to flooding. Further information about specific areas along Walker Brook will be identified once provincial flood modelling is complete.

There are many sites in the City with a medium risk level. These include stormwater infrastructure with storm outfalls potentially being impacted along the riverfront and the mouth of the Water Brook (#1). Sanitary overflows (#2) could all have outfalls submerged along the river; however, lift stations are above the flood risk zone. The wastewater treatment plant's overflow (#3) could be impacted and experience sea water flowing into the plant from the outfall. The lower part of Route 134 (#7), Bridge W030 (#8), and Matheson/Mountain Rd. (# 9) could become impassable due to flooding. The Memorial Regional Civic Centre (#10) could be flooded and inaccessible. The building has both an ammonia plant for ice making and a chlorine plant for the pool which could be impacted. Electrical and critical infrastructure are mostly above flood level, but the building needs a backup generator, as power failures have become an issue. It also has water source heat pumps which must not freeze. The Ramsay Street gas station (#13) has potential for contamination during or after a flood. The municipal garage (#15) could become inaccessible during a Walker Brook flood event or heavy rainfall. Hazardous materials stored on site could lead to contamination.

The remaining identified sites are low risk and include the road leading into the wastewater treatment plant (#4), DTI Bridge W025 (#5), Salmon Plaza (#11), riverfront condos which may see the underground garage flood (#12), Gallant Drive (#14), the sports field and UCT Oval (#16), Restigouche River Experience Centre and RV Park (#18), and electrical buildings along the river front and Salmon Boulevard (#20).

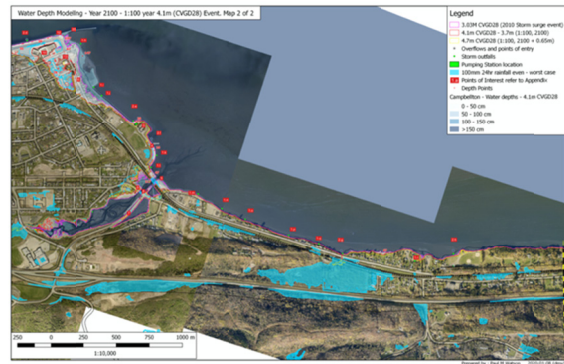
See [Appendix # 3](#) for the full list of risks and the map below (Figures 5 a) and b)) for their locations.

Figure 5 a) & 5b) - At Risk Locations in the City of Campbellton



5a)

(Larger maps are found [in Appendix # 9](#))



5b)

6. Adaptation Actions

This section lists actions that the City of Campbellton can take to adapt to flood risk, they are subdivided under three categories:

- 1) Zoning based on relative flood risk;
- 2) General actions that can be implemented city-wide; and
- 3) Specific actions for sites that have particular risks.

6.1 Zoning and Bylaws

Adopting regulations such as establishing sea level rise zoning and development guidelines as well as coastal zoning based on future sea level rise will limit exposure to risk. New building regulations need to apply minimum built requirements along Walker Brook and low-lying areas along the coast. The City plans to adopt retrofitting regulations to limit exposure to risk based on the principle of “building back better”. Finally, the City will consider using zoning opportunities to establish buffers for flood prone areas.

Precedents exist for flood zone bylaws. For example, bylaw 3.13 of the Town of Sackville, NB’s Zoning Bylaw No. 244, 3.13¹⁸ states that “no development shall be permitted within the Floodplain Area as shown on the “Town of Sackville Hydrographic Map”, unless the structure meets certain floodproofing requirements: The minimum lower elevation of all openings shall be the established flood elevation plus a free board height of 10.2cm (4 in) excluding accessory buildings and agricultural related structure: etc.”.

In Shediac, Zoning Bylaw Z-14-44¹⁹ includes a Sea-level Rise (SLR) Zone. Paragraph 20.4 says that “no main building shall be placed, erected or altered in an SLR zone unless it meets certain minimum requirements such as a minimum elevation of 4.3m for all habitable portions of new buildings. In the case of an existing building, the building shall only be extended if the extension does not reduce the existing building elevation.”

See the full list of possible zoning and bylaw actions for the City of Campbellton with details, leads, partners and timelines in Appendix # 4.

6.2 General Actions

General actions include emergency measures, general stormwater management, general community and municipal actions, communication/education, and local industries and business.

Emergency measures actions focus on establishing a crisis response centre, promoting family flood plans and 72-hour emergency kits, updating the Emergency Measures Plan and organizing mock climate disasters, stockpiling emergency supplies, obtaining backup power for certain services and evaluating escape routes.

¹⁸ Sackville, NB Zoning Bylaw 244. 2016. <https://sackville.com/wp-content/uploads/2016/04/Zoning-By-Law.pdf>

¹⁹ Shediac, NB Zoning Bylaw Z-14-44 2017. http://www.nbse.ca/media-planning/library/SH-BL-Z-14-44_updated_2018-10-31.pdf

Stormwater management actions include evaluating the vulnerability of current wastewater and stormwater management infrastructure, incorporating Walker Brook flood modelling into stormwater management planning once it is available, and creating a stormwater management plan. Reducing run-off in general can be accomplished by planting rain gardens and trees, using permeable asphalt and creating net zero runoff bylaws. Upgrading and separating storm and sanitary sewer systems will ensure they can handle a 1:100 storm event. The City plans to upgrade and manage culverts, and dredge ditches as needed. Finally, the City will promote nature-based solutions including living shorelines, naturalized stormwater management ponds, swales, etc.

General municipal and actions to increase community resilience include incorporating climate risk into the current asset management plan, exploring alternative energy generation, further developing and promoting community transportation system, building a community greenhouse, continuing development of a community garden, joining the Partners for Climate Protection Program, developing a coastal management plan, beginning long-term plans for coastal retreat, and conducting a cost-benefit analysis of municipal climate action projects.

In terms of education and communications, actions include the creation of a website with information about climate change, post climate change related updates and information on social media, target vulnerable populations with education programs that fit their needs, offer education programs for small business and residents to increase their personal resiliency, organize a citizen science monitoring program for water quality and rainfall data, and erect sea level rise signs along the coast. Citizens could start an environmental organization dedicated to climate issues and education. The local Emergency Measures Organization could create a ham radio club to increase communications during storm events and power outages.

Finally, a number of businesses and industry will be impacted by a changing climate. The City plans to research the impacts of climate change on local fishing and snowmobiling, and incorporate findings into the long-term tourism strategy for the municipality. The City will provide education on wet and dry flood proofing for buildings. One of the key sites to be impacted by rising sea levels is the City Centre Mall. The Mall is privately owned and will require its own adaptation plan. While some ideas were discussed during committee meetings as to how the risks could be addressed at the site, such as temporary seawalls, we suggest an engineering-focused assessment of this particular infrastructure using the Public Infrastructure Engineering and Vulnerability Committee assessment tool (<https://pievc.ca>). See the full list of actions, details, leads, partners and timelines [in Appendix # 5](#).

6.3 Site-Specific Actions

The risk assessment identified 21 sites (Figures 5 a) and b), Appendix # 9) that face particular risks and impacts over time. Adaptation options have been developed for each of the sites as applicable, which are provided [in Appendix 6](#).

7. Adaptation Plan Implementation

Implementing the actions proposed in the previous section involves a commitment on the part of the City.

Incorporating the Adaptation Plan into Municipal Operations:

1. Present Plan to City Council for approval;
2. Implement adaptation plan throughout municipal operations;
3. Update policies and regulations throughout municipal operations to reflect climate change and adaptation requirements;
4. Provide each City Department with maps, list of actions for their respective area and encourage City Departments to develop their respective future plans based on the information contained in the Adaptation Plan;
5. Communicate the risk and vulnerability assessment, as well as planned actions to all necessary levels of governments, where applicable, for example, NB's Department of Transportation;
6. Update hydrographic network mapping, flood risk assessments and maps as updated information becomes available. Incorporate scenarios into inland flood risk maps when flood scenario modeling becomes available (2020).

Planning & Research:

7. Develop and implement new flood risk zoning bylaws and regulations in the next Municipal Plan Review.

Community Engagement:

8. Add climate change adaptation information to the City's website as soon as possible (e.g., City of Bathurst's plan is available online: <https://www.bathurst.ca/en/services/communications/19/climate-change-adaptation-plan>);
9. Develop City information package for homeowners (e.g., City of Moncton's Homeowner's Guide to Flood Protection: <https://www.moncton.ca/guides-moncton-environment/climate-change-adaptation>);
10. Work with local individuals, committees, or a local environmental non-profit (watershed group) to carry out public education and outreach to raise awareness and inform residents.

Oversight and Ongoing Updates:

11. Establish a permanent Climate Change Action Committee including municipal staff, councillors and community members, to provide oversight and further direction to the implementation of the Adaptation Plan;
12. Have municipal departments submit annual progress reports on implementing adaptation actions;
13. The Adaptation Plan should be updated at least every 3 years, or as new information becomes available.

8. Glossary of Terms

Adaptation—To adjust actions, policies, and planning in response to actual or expected climatic hazards to moderate their effects and reduce their potentially negative impacts.

CGVD2013—CGV stands for geodetic vertical datum, and is a reference standard for heights, 2013 describes the year it was implemented. CGV represents the tidal datum or mean water level from five tide gauges in Canada.

Climate Change—Climate change refers to any significant change in the measures of climate lasting for an extended period of time, including major changes in temperature, precipitation, or wind patterns, and others, that occur over several decades or longer.

Geographic Information Systems—Abbreviated as GIS, this is a tool that helps analyze and present spatial information, such as where houses may get flooded.

Growing Degree Days—Growing Degree Days (GDD) is a measure of the average annual number of days where temperatures fall within a temperature range permitting plant growth.

HHWLT—Higher high-water large tide describes the average of the highest high-water levels as an average over 19 years.

Resilience—The capacity to rebound after the impacts from hazards with minimum damage to social well-being, the economy, and the environment.

RCP 8.5 model—RCP 8.5 (RCP: Representative Concentration Pathways) is a climate model that predicts future climates, using future high energy demand and GHG emissions in the absence of climate change policies as basic assumptions. Developed in 2011, this model represents the pathway with the highest greenhouse gas emissions. (<http://www.iiasa.ac.at/>)

Return Period—The return period is an estimate of the average interval of time between similar flood events based on historical records and predictions about future climatic variability.

Sea-Level Rise—An increase in the mean level of the ocean. Sea-level is measured by a tide gauge.

Storm Surge—An abnormal rise in sea-level accompanying a hurricane or other intense storm, due to low atmospheric pressure and strong, on-shore winds, which may lead to damaging waves and coastal flooding.

Threat (Hazard) —Anything that can adversely affect a community.

Vulnerability—The degree to which a community is exposed to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.

9. Resources

Beltaos. 2002 in Bush, E. and Lemmen, DS., editors. 2019. Canada's Changing Climate Report, Government of Canada

Daigle, Real. 2014. Updated Sea-Level Rise and Flooding Estimates for New Brunswick Coastal Sections. (<https://atlanticadaptation.ca/en/islandora/object/acasa%253A731>)

El-Jabi et al. 2013 in Bush, E. and Lemmen, DS., editors. 2019. Canada's Changing Climate Report, Government of Canada

Government of New Brunswick. 2010. Flood Details.
(<https://www.elgegl.gnb.ca/0001/en/Flood/Details/324>)

Government of New Brunswick. 2014. New Brunswick Flood Risk Reduction Strategy.
(www.gnb.ca)

IPCC. 2012 Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 3-21.

IPCC. Intergovernmental Panel on Climate Change (<http://www.ipcc.ch/>)

Martin, Jean-Philippe & Yann Chavaillaz. 2019. Chaleur RSC Regional Climate Change Adaptation Plan. WSP Canada Inc.

New Brunswick Department of Environment and Local Government website.
(https://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/climate_change/content/climate_change_indicators.html)

Oldfield, Eddie & Julie Bunker. 2019. Climate Risk and Resilience Assessment City of Campbellton. QUEST.

Roy, Pilippe and David Huard. 2016. Future Climate Scenarios Province of New Brunswick. Ouranos

Sackville, NB Zoning Bylaw 244. 2016. <https://sackville.com/wp-content/uploads/2016/04/Zoning-By-Law.pdf>

Shediac, NB Zoning Bylaw Z-14-44 2017. http://www.nbse.ca/media-planning/library/SH-BL-Z-14-44_updated_2018-10-31.pdf

10. Appendices

Appendix # 1 - Summary of QUEST Report on Risk and Resilience in Campbellton

The 2019 QUEST report *Climate Risk and Resilience Assessment City of Campbellton* found numerous strengths to deal with climate change in Campbellton. Some of which include:

1. Protected green spaces
2. Presence of EMO, emergency planning
3. Incorporating climate risks in asset management planning
4. Undergoing a municipal climate change adaptation plan
5. Collaboration with neighbouring communities
6. Funding available via NB ETF, FCM, Gas Tax, etc.
7. Safe evacuation routes identified
8. Commercial services - food, rental agencies, etc.
9. Good communication by mayor and council
10. Emergency gathering point has been identified
11. Back-up power for communication towers
12. Back-up power (generators) for vital services (water, sewer, civic centre, RCMP, hospital, nursing home, seniors complex, etc.)
13. Partial storm and sanitary sewer separation

QUEST also identified opportunities to improve resilience in Campbellton:

1. There is no forest fire prevention strategy or restrictions for vegetation. A hospital, several neighborhoods, are adjacent to forest.
2. Opportunities for stormwater retention ponds to reduce flooding.
3. Municipality does not have copies of EM Plans for local schools, hospital or nursing home, or a voluntary registry of vulnerable persons (although Red Cross might).
4. Current asset management plan doesn't consider climate risk.
5. Current land use plan doesn't consider future climate risk - Needs to discourage development, or apply minimum build requirements, all along Walker Brook and low lying subdivisions along the edge of coast, unless flood protection measures are taken.
6. Needs to encourage new development or "Build back better" in low-risk areas, including: Between Roseberry Street and Val d'Amour Road; Between Sunset Drive and Highway 11; Between Route 134 and Highway 11.
7. Disaster risk assessments are not incorporated into all relevant local development planning on a consistent basis, but the City is starting to.
8. Key infrastructure located in flood risk zone - consideration for future planning and bylaws.
9. Improvement needed to regulations for housing and development to take current and projected climate risk into account (e.g., flooding).
10. Limited municipal budget to carry out risk reduction activities (e.g., climate adaptation, flood risk reduction, back-up power).

11. No local economic incentives for investing in disaster risk reduction for households and businesses (e.g., reduced insurance premiums for households, tax holidays for businesses).
12. It was noted there is a lack of resources and programs in schools / health facilities to improve resilience or educate the community.
13. There are no stockpiles of relief supplies.
14. A declining population, an ageing population, and low-income population contribute to higher vulnerability in the area and a need for social programs and extra planning for extreme events
15. Improvement needed for communication with all groups and public
16. Does not know HAM radio operators or alternative communication mechanisms.
17. Does not have back-up power for 2 lift stations, emergency shelters, schools, animal shelters, grocery, bank and may need alternative sources for fuel in case of interruptions.
18. Has not implemented alternate generation sources within the community - relies on grid. opportunities for solar PV identified at Hospital, Civic Centre, City Hall, CCNB/Schools, Restigouche River Experience Centre. Renewable heat possible at Hospital, Civic Centre, municipal garage, and from water treatment. Micro-hydro in Walker Brook, at outfalls, and wind energy on sugarloaf, Uni Village and Nuns, are other options. Potential for district heat identified in downtown core.
19. No flood protection for wastewater treatment plant and lift stations, Outflow pipe is not raised above 1 in 100 year flood events.
20. Particularly vulnerable to flooding (e.g. from storm surge, sea level rise) include Memorial Regional Civic Centre, Restigouche River Experience Centre (RREC), Library, RV Park, Waste Water/Sewage Treatment plant, City Hall, Municipal Dam / Reservoir (to breach), Senior's complex/school, bridge access points and wharf. Schools may be vulnerable to extreme flooding.
21. May upgrade culverts to prevent flooding.
22. Unknown how many days the City has food if there are interruptions to supply.
23. There is no greenhouse. The nearest farms are outside the municipal boundaries.

Appendix # 2 - Community Workshop

On September 10th, 2019 eighteen people attended the first public engagement session on climate change adaptation as part of the City of Campbellton's adaptation planning process. The session had been promoted by the City on its social media pages, with posters around the community, and in the local paper.

The three-hour session involved four presentations and a chance for the community to look at flood risk maps and provide comments and input into areas, infrastructure, buildings, people, etc. that are at risk and vulnerable to flooding. Community members in attendance also wanted to discuss other climate change impacts including winter storms, ice storms, heat waves, etc.

Participants were invited to have a closer look at the flood maps on their table and discuss what and who are vulnerable, where are the problem areas, if they agreed with the planning committee's already identified priority sites. They were also invited to provide input on adaptation actions. Some participants wanted to also talk about other climate change impacts beyond flooding and how to adapt to each one.

Public Engagement Session Flood Risk & Climate Change Adaptation in Campbellton What's at risk, who's vulnerable and what can we do about it?



Tuesday, September 10th, 2019 5:30pm-8:30pm
Convention Center at the Regional Memorial Civic Center
44 Salmon Blvd., Campbellton, NB

AGENDA

5:30-6:00pm Refreshments, Networking and Map Viewing
6:00-6:10 Welcome and Introductions
6:10-7:40 Presentations:
• Climate Change Projections and Impacts in New Brunswick, Pratima Pradhan, DELG
• Sea-Level Rise and Coastal Flooding, Réal Daigle, Environmental Consultant
• Campbellton's Climate Adaptation Plan, Mayor of Campbellton
• Community-Based Adaptation Activities, Armande Marlin, EOS Eco-Energy
7:40-8:10 Map Validation and Table Discussions
8:10-8:15 Reporting Back
8:15-8:30 Wrap Up and Next Steps

FREE - All welcome - For more information: Paul Watson, Paul.Watson@campbellton.org or 389-3700



What is at Risk from Flooding?

- Major transportation routes:
 - Ramsay Street
 - Area at the Iron Bridge
 - "Subway" or tunnel under the railway
 - Rail routes
 - Highways
 - Local streets
- Ambulance NB station on Dover St. (along Walker Brook) so crisis and EMO response may be negatively impacted
- Civic Centre – should not be used as an emergency shelter, we need somewhere higher
- City Centre Mall
- Sewage treatment lagoon will be cut off (access road would be flooded)
- Not much vacant land left in the city... where can we direct people to develop outside of vulnerable areas?
- Properties along Walker Brook are at risk
- The hospital is also too far to walk to from town
- A stopped/derailed train could cut off part of town, cut people off from hospital
- Riverbanks, low lying areas

Who is at Risk?

- Lower income families, NB Housing properties throughout the city

- Seniors, seniors apartments, nursing home
- Low income and seniors also lack transportation
- Young families, children
- Handicapped people – a large population and they drive in wheelchairs
- Low income families, especially those by Walker Brook



Adaptation Actions

- Look into free trees to give out to City residents and provide guidelines on how to plant trees on your property.
- Plant trees by the City Centre Mall in the area between the mall and the RV park.
- Library could look at Grant Connect
- Use permeable asphalt in areas prone to flooding (e.g., the mall), or small-scale options
- Work with communities (Listugui, Pte-a-la Croix, Restigouche, Bay de Chaleur) to dredge the river to reduce risk of flooding the railway
- A broader regional climate change plan is needed but it will be difficult to achieve consensus amongst communities, “we are not there yet” when it comes to regional planning but maybe do a Restigouche east and Restigouche west plans?
- Try to sell homes and move to higher ground
- Plant trees that do not grow higher than power lines
- Do more public education and explain how to prepare for different climate impacts
- What can be done in schools?
- People will need to check in on NB Housing properties, seniors
- Public transport is missing
- Post updates and information on social media
- Possible benefits from an extended growing season
- A crisis response centre with devoted resources

Other Climate Impacts to Plan For

- Freezing rain (risks for power lines, downed trees, etc.)
- Snowstorms (some residents felt this was the number one concern due to their frequency and has risks for public works employer fatigue, impacts on businesses etc.)
- Heat waves (risks for power supply grid, vegetation, water supply, everyone)
- Hailstorm

Additional Comments Heard

- Participants wanted to hear from the EMO Coordinator/fire chief
- A community survey was suggested to try and get more input and reach other community members
- Post updates with the plan and adaptation on social media

Appendix # 3 - Risk Areas for the City of Campbellton

The sites have been identified by workshop and meeting participants as most at risk from flooding. The level of risk indicated in the table below (high, medium, low) refers to the significance of the impact on the location.

High: Significant disruption and/or damage, it happens repeatedly and is significant; has long-term impact and has potential to cause extensive damage; requires significant EMO response; repair costs significant

Medium: Some disruption in services and operations, moderate effects, affects citizens moderately, repair costs are moderate; temporary displacements and may have some broader impacts

Low: Little disruption or damage, very localized, minimal effects on operations and/or functioning, effects on citizens is low or minimal, and the repair costs are low.

Site #	Location	Climate Risk	Risk Level	Impact
1	Storm water infrastructure (approx. 18 outfalls)	Coastal flooding with a 4.7 m storm surge event	Medium	Storm outfalls that could be impacted. Along both the river and the mouth of Walker Brook. Should sea level + storm surge rise to 4.7m, these outfalls would be submerged.
2	Sanitary Infrastructure (7)	Coastal flooding with a 3.3m storm surge event and 4.1m depending on location	Medium	Sanitary overflows that would all have outfalls in submerged areas along the river. 2 are connected to lift stations. The lift stations themselves are above the flood zone.
3	WWTP (waste water treatment plant)	Wastewater plant is okay even at 4.7m flood but coastal flooding will impact storm outfalls	Medium	Built in 1983; overflow could be impacted and experience sea water flowing into the plant from the outfall. Treatment plant has seen many upgrades over the years. Pumping station was almost flooded in 2010, has been upgraded since then, and a backup generator is in place as well as two new overflow pumps. Wooden retaining wall was improved to keep water out. No current plans for moving the plant; or for upgrading.
4	Road leading into the WWTP	Coastal flooding with a 4.7 storm surge	Low	Could become impassable.
5	Bridge – DTI W025	Coastal flooding with a 4.1 m storm surge	Low	Could become impassable.
6	Ramsay St.	Coastal flooding with at least a 4.1 m storm surge	High	Could become impassable. There was water in basements in 2010, and problems are persisting. Many homes have

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				concrete block foundations. The shoreline behind Ramsey is silty material, plugs outflows. Residents have complained of issues in the past. This is the most highly impacted street in the community. Education required.
7	Part of Rte. 134	The lower section could flood with a 3.03m storm surge	Medium	Could become impassible. 'Promenade des Religieuses Hospitalières de Saint-Joseph Drive'. While it is not part of Route 134 it is an important link between 134 and Route 11 the main highway running just south of the City.
8	Bridge – DTI W030	Coastal flooding could be possible with a 3.03m surge	Medium	Could become impassible. It is the only sanitary connection to the Richardsville portion of town, was almost affected by 2010 storm surge. While the water came close to this structure during this event, it never actually flooded.
9	Matheson/Mountain Rd.	Coastal flooding could impact parts of Mountain Road at 4.7m	Medium	Could become impassable and potential impact to water/sanitary infrastructure running under bridge.
10	M.R.C.C (Memorial Regional Civic Center)	Coastal flooding with a 4.1 m surge would flood the parking lot and a surge of 4.7 would flood the building and surrounding downtown area	Medium	Could be flooded and inaccessible; building has both an ammonia plant for ice making and a chlorine plant for the pool which could be impacted. Electrical and critical infrastructure mostly above flood level; needs a backup generator, as power failures have become an issue. Has water source heat pumps which must not freeze. The civic centre is about 27 years old.
11	Salmon Plaza	Coastal flooding with a 4.1m storm surge	Low	Water Park (splash pad)/ kiosk, amphitheatre and tourist information centre (most vulnerable) could be submerged.
12	Condos along (XX street?)	Coastal flooding with a 3.03 m storm surge	Low	With underground parking (new #) – parking could be flooded.
13	Ramsay St. Gas Station	Coastal flooding across the street with 4.1m surge. Station could become inaccessible at 4.7m surge.	Medium	Could be impacted – potential for contamination during/after a flood event. This could also limit access to fuel during an event; there is a second location across the road with potentially old gas tanks in the ground (former gas station).
14	Gallant Dr.	Inland flooding possible with 100mm of rain in 24 hrs	Low	Could become impassable during a Walker Brook flood event or heavy rainfall but would be at a high enough elevation as to not be impacted by a storm surge event. Further information about specific areas will be identified once provincial flood modelling is completed.

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15	City Garage	Inland flooding possible with 100 mm of rain in 24 hrs	Low - medium	<p>Could become inaccessible during a Walker Brook flooding event or heavy rainfall but would be at a high enough elevation as to not be impacted by a storm surge event.</p> <p>Potential for contamination of the site due to the contents of the building – oil, diesel, various other hazardous materials/products on site.</p> <p>Salt/Sand shed could also be flooded potentially contaminating stored materials.</p> <p>Further information about specific areas will be identified once provincial flood modelling is completed.</p>
16	Sports field – UCT Oval	Inland flooding possible with 100 mm of rain in 24 hrs	Low	<p>While not considered critical infrastructure, it could be flooded during a Walker Brook flooding event or heavy rainfall but would be at a high enough elevation as to not be impacted by a storm surge event.</p> <p>Further information about specific areas will be identified once provincial flood modelling is completed.</p>
17	City Center Mall	Coastal flooding possible with a 4.1 m storm surge	High	<p>Many private and public lessees; built on old piers, building stable, but underground has been washed out in places; the location is filled-in riverbed. Has had water come up through floors in the past. Basement rooms have been flooded with high tides in the past. Has an underground pumping station. Mall built in the late 70s. Houses provincial courts and many other tenants.</p>
18	Restigouche River Experience Center and RV Park	Erosion	Low	<p>New development, built on old landfill; erosion concerns, no flood concerns.</p>
19	Sister Green Housing	Inland flooding possible with 100 mm of rain in 24 hrs	High	<p>Potential flooding in low-income housing areas. This could be impacted during a Walker Brook flooding event or heavy rainfall but would be at a high enough elevation as to not be impacted by a storm surge event.</p> <p>Further information about specific areas will be identified once provincial flood modelling is completed.</p>
20	Electrical buildings	Coastal flooding with a 3.03m storm surge	Low	<p>Feeding shore lights, waterfront recreational lighting, Salmon Blvd.</p>
21	Walker Brook	Inland flooding possible with 100	High to	<p>The brook has been rerouted twice. Residents in the area</p>

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		mm of rain in 24 hours Erosion	medium	get concerned when the brook gets high. Culverts are owned by DTI Further information about specific areas will be identified once provincial flood modelling is completed.
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Appendix # 4 - Zoning and Bylaws

Short-term means 1-2 years, medium-term means 3-5 years and long-term means more than 5 years.

Adaptation Action Zoning & Bylaws	Details	Lead and Support	Time Frame
Adopt regulations to limit exposure to risk	<ul style="list-style-type: none"> Establish sea level rise zoning and development guidelines for the City's flood vulnerable areas (see Southeast Regional Service Commission zoning) Implement coastal zoning based on future sea level. Example: 1-year zone: no development should be allowed; (2) 25-year zone: before having a better understanding of coastal hydrogeomorphological dynamics at the scale of the RSC, impose a moratorium in the development inside the 30 m buffer beyond the 25-year zone. (3) 100-year zone: allow for development depending on the sensitivity to storm surges. Built at an elevation above the 100-year return period storm surge in 2100. New permanent structures located below that line should be built with immunization measures that make them resilient to storm surges. Examples: Town of Sackville 	City Restigouche RSC Planning Department	Mid-term
Develop new building regulations with climate change considerations for both municipal and private buildings	<ul style="list-style-type: none"> Apply minimum build requirements, all along Walker Brook and low-lying subdivisions along the edge of coast, unless flood protection measures are taken. Needs to encourage new development or 'Build back better' in low-risk areas, including: Between Roseberry Street and Val d'Amour Road; Between Sunset Drive and Highway 11; Between Route 134 and Highway 11. Other possibilities include: Thompson Rd, Valley Rd, and Lily Lake Rd (however only one access into town, and adjacent forest (i.e. fire risk)) For example, in Sackville entrances must be above flood level. City to look at building bylaws to mandate raising electrical panels, oil tanks, and when building permits are needed, etc. 	City Restigouche RSC Planning Department	Mid-term
Adopt retrofitting regulations that limit exposure to risk	<ul style="list-style-type: none"> Forbid retrofitting or reconstruction of infrastructure in the 25-year zone when the damages to the infrastructure caused by coastal flooding or erosion exceed half of the real value attributable to the real property (Gazette Officielle du Québec, 2017); Allow retrofitting or reconstruction of infrastructure in the 100-year zone when the damages to the infrastructure caused by coastal flooding or 	City Restigouche RSC Planning Department	Mid-term

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	<p>erosion exceed half of the real value attributable to the real property (Gazette Officielle du Québec, 2017).</p> <ul style="list-style-type: none"> ● Reconstruction should include immunization measures to make them resilient to coastal hazards. ● Consider relocation of specific infrastructure and citizens. 		
Consider using zoning opportunities to establish buffers for flood prone areas	Examples: Setbacks, Land swaps, Subdivision bylaws, Development standards	City Restigouche RSC Planning Department	Mid-term

Appendix # 5 - General Actions

Short-term means 1-2 years, medium-term means 3-5 years and long-term means more than 5 years.

Adaptation Actions	Details	Lead	Time Frame
Emergency Measures			
Establish a crisis response centre with devoted resources	City and Emergency Measures (EM) to create a crisis response centre with resources and stockpiled supplies.	EM City	Mid-term
Promote family flood plans and family safety plans	Emergency Measures to promote the importance of a family flood plan. Provide templates for families to fill out with emergency numbers, evacuation routes, meeting locations, emergency kit packing list, insurance information, etc.	EM	Short-term
Promote 72 hour kit bulk purchase	Emergency Measures to offer a bulk purchase of 72 hour kits from the Red Cross. A bulk discount applies and shipping costs can be saved too. Costs of kits are reduced. Could also be used as a fundraiser.	EM Red Cross	Short-term
Continue to update EMO plan	City Emergency Measures to continue to update emergency measures plan and communicate the plan and local resources to the public. Also work with schools, hospital, nursing home to develop their own Emergency Measures plans.	EM	Ongoing
Organize mock climate disaster scenarios	Have training exercises involving emergency services and local responders to respond to severe, wide area flooding, erosion, storm events, fires and improve delivery of services and response times.	EM	Ongoing
Develop a forest fire prevention strategy	Research and write a strategy to help reduce the risk of forest fires within the municipal boundary.	EM	Mid-term
Develop a registry of vulnerable people	A registry of vulnerable people (seniors, low income, those with medical concerns such as dialysis, etc.) will help Emergency Measures know who to check on and assist first during storm events.	EM	Short-term
Stockpile emergency supplies (water, cots, food, generators, etc.)	Similar to other at-risk municipalities, work to stockpile emergency supplies for future storms.	EM	Short to mid-term
Obtain back-up power for school, lift stations, animal	Emergency Measures to update list of buildings with generators. Contact provincial EMO for list for all buildings in municipality with	Schools, shelter, stores, etc.	Long-term

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shelter, grocery store, emergency shelter, bank	backup service. Emergency Measures to help vital services obtain funding for backup power.	EM	
Evaluate escape routes	Some neighborhoods, homes and businesses, have only one access road for emergency services and evacuation. Evaluate if these routes will be accessible. Communicate with residents as early as possible if they will need to evacuate ahead of storm or flood.	City	Short-term
Stormwater Management			
Continuously evaluate the vulnerability of current wastewater and stormwater management infrastructure	Evaluate 18 Storm outfalls and 8 Sanitary overflows.	City	Ongoing
Incorporate Walker Brook flood modeling into stormwater management planning and actions	Once the modelling is available, the adaptation plan and any stormwater management plans need to be updated to reflect new information.		Short-term
Create a stormwater management plan	They City will identify vulnerabilities and future work for all infrastructure possibly using PIEVC; combined with Asset Management Plan	City	Mid-term
Reduce the amount of run-off	Plant rain gardens throughout the City. Use permeable asphalt in areas prone to flooding (such as the City Centre Mall), or small-scale options. City to look at developing a net zero run off bylaw.	City, community group(s), property owners	Short-term Mid-term Mid-term Mid-term
Establish a Tree Program to reduce run-off and decrease heat islands	Trees take up more water than grass and help decrease temperature in summer, provide shade, etc. Look into free trees to give out to City residents and provide guidelines on how to plant trees. Look at creating tree bylaw to conserve trees in urban core, replant trees that are to be removed, etc.	City Funding support from Tree Canada and TD Bank Friends of the Environment	Short-term
Upgrade and separate storm and sanitary sewer systems	Ensure they can handle a 1:100 storm event	City	Ongoing
Upgrade & management of culverts	Regular maintenance to continue and upgrade outdated culverts	City DTI Depending on location	Ongoing

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Dredging, ditching, etc	Regular maintenance. Public education about keeping ditches clear.	City	Ongoing
Promote actions that use nature-based solutions	Promote living shorelines as stabilization option as opposed to engineered solutions like retaining walls. Promote naturalized stormwater ponds, swales, etc. which have multiple benefits for wildlife, people, recreation, well-being, etc. Look at eventually creating a bylaw that promotes nature-based solutions.	City Restigouche RSC Planning Department Provincial resource groups: New Brunswick Environmental Network (BRACE program, etc), Ducks Unlimited Canada	Short-term
Update climate data	Update data on climate projections, sea level rise, etc. as they become available	City DELG	Ongoing
General Municipal/ Community Actions			
Current asset management plan to consider climate risk	Look at Saint John, NB Engineering Project as example. Use existing software to flag climate change issues.	City Federal funding	Short-term
Explore alternative energy generation for Campbellton (wind, solar)	Local clean, renewable energy generation will increase local resiliency.	City QUEST, Beausejour Renewable Energy	Mid-term
Further develop and promote community transportation system options	To assist those who can't drive (low income, seniors, etc). Find out what clients the Restigouche Community Transport group serves and what gaps may need to be filled.	City Restigouche Community Transport (regional non-profit)	Ongoing
Build a community greenhouse	To increase local food security, extend growing season, provide fresh local produce without the transportation costs. Increase availability of fresh produce during storm events.	Citizen group?	Short to mid-term
Start a community garden	A local group has started a community garden. Will also increase local food security and increase community resilience.	Citizen group	Ongoing
Conduct municipal asset mapping with a climate risk lense	Asset mapping to consider climate risks.	City	Ongoing

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Join the Partners for Climate Protection Program (PCP)	A national program that reduces emissions at the local level in 5 steps.	City Partners for Climate Protection Program (FCM)	Mid-term
Develop a watershed management plan	Monitor local surface water quality and develop a watershed management plan.	City or nearest watershed group?	Mid-term
Create an integrated sustainability plan	Consider actions related to community sustainability, including environment, social and economic aspects.	City	Mid-term
Develop a coastal management plan and begin long-term planning for managed coastal retreat and	Explore how to expand municipal boundary inland and begin planning for moving infrastructure and buildings further inland.	City	Long-term
Cost-benefit analysis of particular projects listed here	Perform cost-benefit analysis for projects listed above, determine best options	City	Ongoing
Other general ideas to consider as needed	Retaining walls, dykes, rip rap Breakwaters, bio-engineered stabilization, sea walls, dykes Land acquisitions and land bank	City	As needed
Communication/Education			
Establish a local environmental organization focused on climate actions	This group would aid in climate change education and undertake local projects such as rain gardens	Citizens group	Short term
Carry out public education and explain how to prepare for different climate impacts	Creative workshops, speakers, field trips, social media campaigns, newsletters, newspaper articles, etc. Provide education on raising buildings, alternative construction. Provide education on wet and dry flood proof residential buildings.	City, citizen group	Ongoing
Provide education in local schools on climate change and adaptation	Provide education at all levels on sustainability, nature appreciation, climate science, natural approaches, wetlands, renewable energy, food preservation, water quality, climate stress, etc.	Schools, citizen's group With help from environmental groups	Short term and ongoing
Post updates and information on social media	Share flood risk maps, information, tips on how to prepare for storms, reduce flood risk, etc. Send emergency alerts. Communicate climate actions taken by the City, etc.	City	Ongoing
Target vulnerable populations	Provide information on services such as local transportation service,	City	Short-term and

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with education programs to fit their needs	what to put in an emergency kit, family flood plan template, emergency phone numbers, etc.	EMO	ongoing
Provide educational opportunities for small businesses and residents to increase resiliency	Offer workshops on specific topics such as ham radios, food preservation, climate stress	City Local NGO	Short-term
Educate community about human health risks related to climate change	Ticks, climate stress/eco anxiety, heat stroke, contaminated flood waters, etc.	Public Health City	Short-term
Develop a website (or pages on the municipal site) to communicate about climate change impacts and adaptation	Include actions citizens can take, showcase steps municipality is taking, data portal, maps, etc	City	Short-term
Develop citizen science monitoring program	Collect water quality data, rainfall data, wind speed, use CocoRHaS monitoring equipment (https://www.cocorahs.org), monitor shoreline erosion, invasive species, etc.	City Local university	Mid-term
Erect a series of sea level rise signs along the coast	List water levels today and in 100 years. List actions local residents can take to adapt and how they can use natural approaches to reduce risk	City	Mid-term
Implementation of resources and programs in schools / health facilities to improve resilience or educate the community	Have teachers join the New Brunswick Environmental Network's bilingual Climate Change Education Community of Practice (nben.ca)	Local schools Resources from the New Brunswick Environmental Network	Ongoing
Create a ham radio club	To increase ability to communicate when all other forms of technology break down during extended power outages	EMO WestCumb Ham Radio or other clubs in the Province	Mid-term
Local Industries and Businesses			
Research impacts of climate change on local tourism – fishing, snowmobiling, etc,	To be incorporated into long-term tourism strategy for the City	City	Long-term

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Encourage wet and dry flood proof buildings	City to provide education to local businesses on how to wet and dry flood proof their buildings	City Businesses	Short-term
Develop an adaptation plan for the City Centre Mall	Possibly use the Public Infrastructure Engineering Vulnerability Committee (PIEVC) protocol to develop an assessment and plan for the City Centre Mall. https://pievc.ca/ (note: requires an engineering company familiar with PIEVC)	City Engineering Firm to be selected	Mid-term

Appendix # 6 - Adaptation Actions for Specific Sites in the City of Campbellton

Short-term means 1-2 years, medium-term means 3-5 years and long-term means more than 5 years.

Site #	Site Name	Risk Level (see Appendix 3)	Adaptation Actions	Lead & support	Time Frame/ Status
1	Stormwater infrastructure (approx. 18 outfalls)	Medium	Gravity fed system Continue to separate still-combined portion of the system New projects all have to be separated systems Leaks need repair	City	On-going
2	Sanitary Infrastructure (7)	Medium	Ensure pumps can operate during flood events (generators) – 2 small lift stations are above flood level but will be islands Relocate the most susceptible infrastructure in the long term	City	On-going Long-term
3	Wastewater treatment plant (WWTP)	Medium	Relocate in the long term Dyke/protect until relocation becomes feasible Ensure backup generators remain functional Improvements have been made in the past	City	Long-term On-going On-going
4	Road leading into the WWTP	Low	Raise road so that it is not at risk from flooding	City	Mid-term
5	Bridge – DTI W025	Low	Raise bridge	DTI	Mid-term
6	Ramsay St.	High	Retreat/relocate private homes Flood proof all buildings Educate residents of risk	City	Long-term Short-term Short-term
7	Part of Rte. 134	Medium	Possibly raise	City & DTI	If needed
8	Bridge – DTI W030	Medium	Raise bridge Ambulance bay is near this area and could be at risk of being cut off, could look at alternative location	DTI	Long-term
9	Matheson/Mounta in Rd.	Medium	Raise, ensure no backup water into houses, ensure exit from road possible	City; Bridge owned by DTI	Mid-term
10	M.R.C.C.	Medium	Select alternative location for emergency shelter	City	Short-term

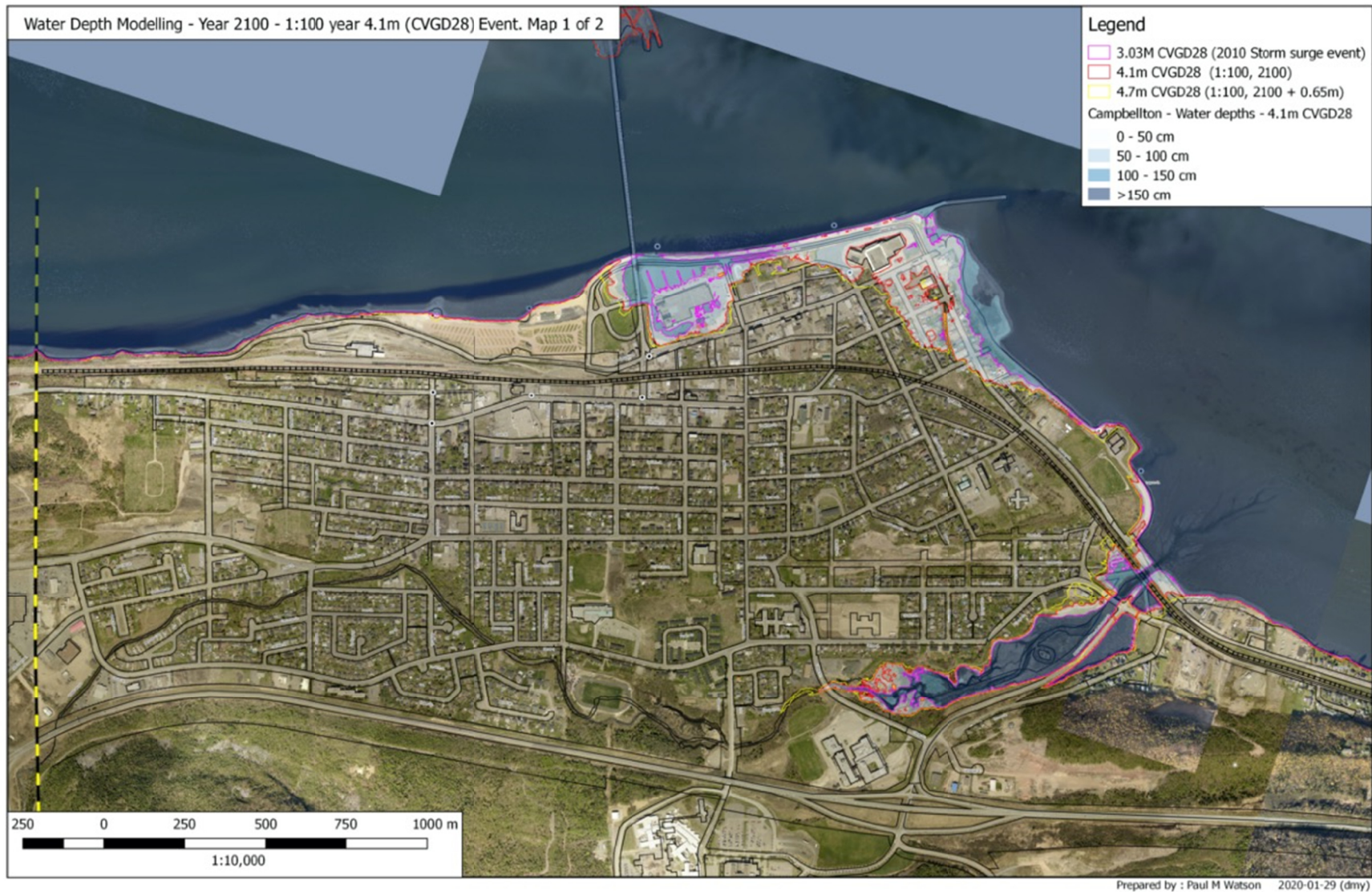
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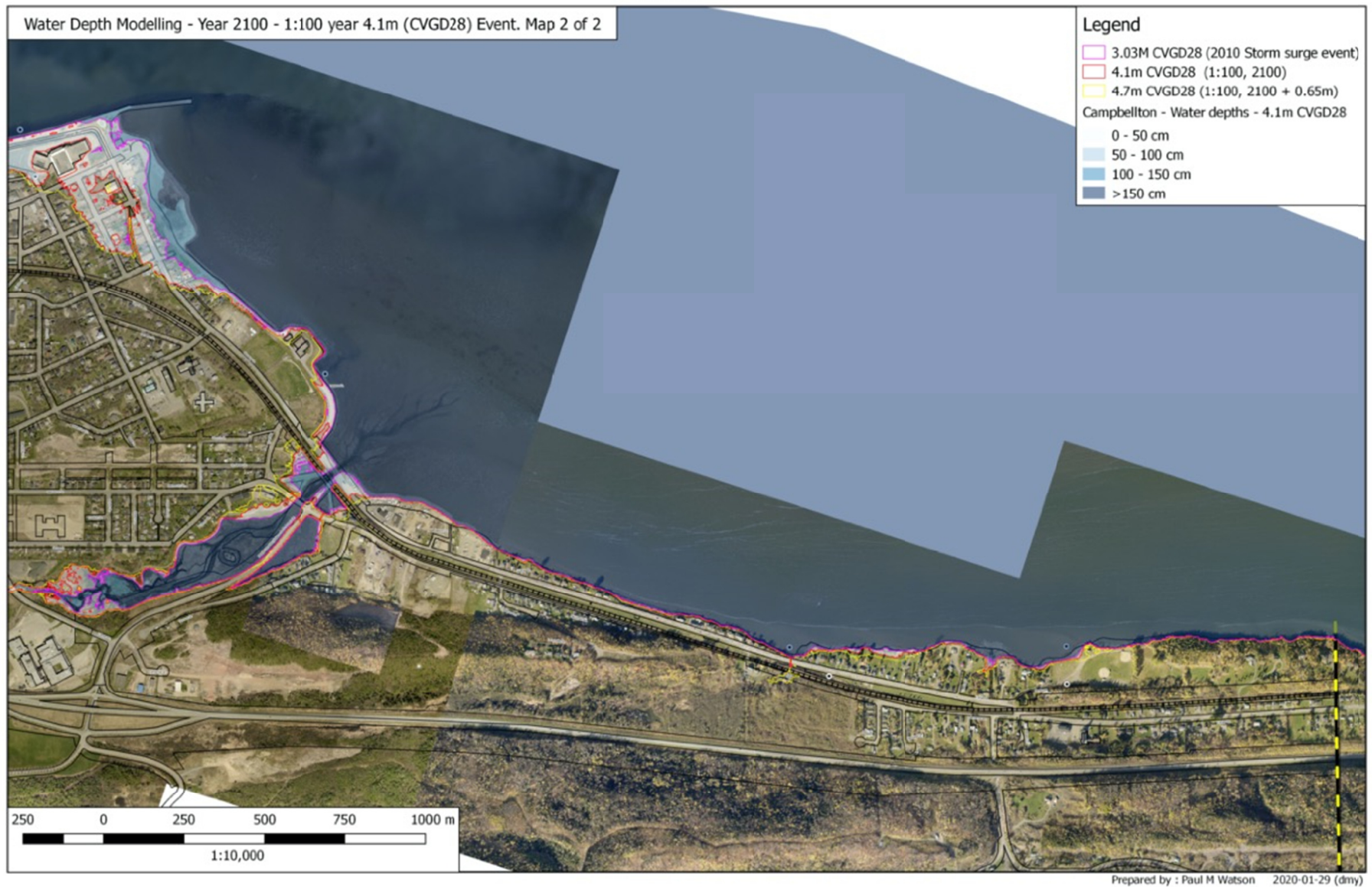
	Memorial Regional Civic Center		Ensure no sensitive equipment is on first floor Flood proof building Assess cost-benefit over time of keeping the building upgraded and flood proofed Consider relocating building Consider backup power for sections of building		On-going On-going Mid-term Long-term
11	Salmon Plaza (water park & splash pad)	Low	Low-risk, but may need to be cleaned and verified for damage after inundated with flood waters. Assess economic cost-benefit to maintaining the splash pad if flooded frequently	City	On-going Mid-term
12	Condos (along Salmon Blvd)	Low	Underground parking: ensure warnings of flood events is passed on to condo residents Inform residents and owner of risk		On-going
13	Ramsay St. Gas Station	Medium	Raise building, relocate, pump water, sand bags, wet/dry flood proof Consider removing underground storage tanks Inform owner of risk	Business owner	On-going Mid-term
14	Gallant Dr., Bridge – DTI W040	Low	Raise Bridge	DTI	Mid-term
15	City Garage	Low	Ensure fuel tanks and other equipment that can be damaged by a flood are located outside the risk area or properly secured and protected	City	On-going
16	Sports field – UCT Oval	Low	Low-risk Accommodate for flooding (do not use impermeable surface in this area)	City	On-going
17	City Center Mall	High	Conduct an engineering study to evaluate flood risk reduction efforts (seawall, sandbags, re-location, etc.)	Business owner	Short-term
18	Restigouche River Experience Center and RV Park	Low	Low-risk Erosion of this former waste disposal site needs to be monitored	City	On-going
19	Sister Green	High	Education about flood proofing homes	City to	Short-term

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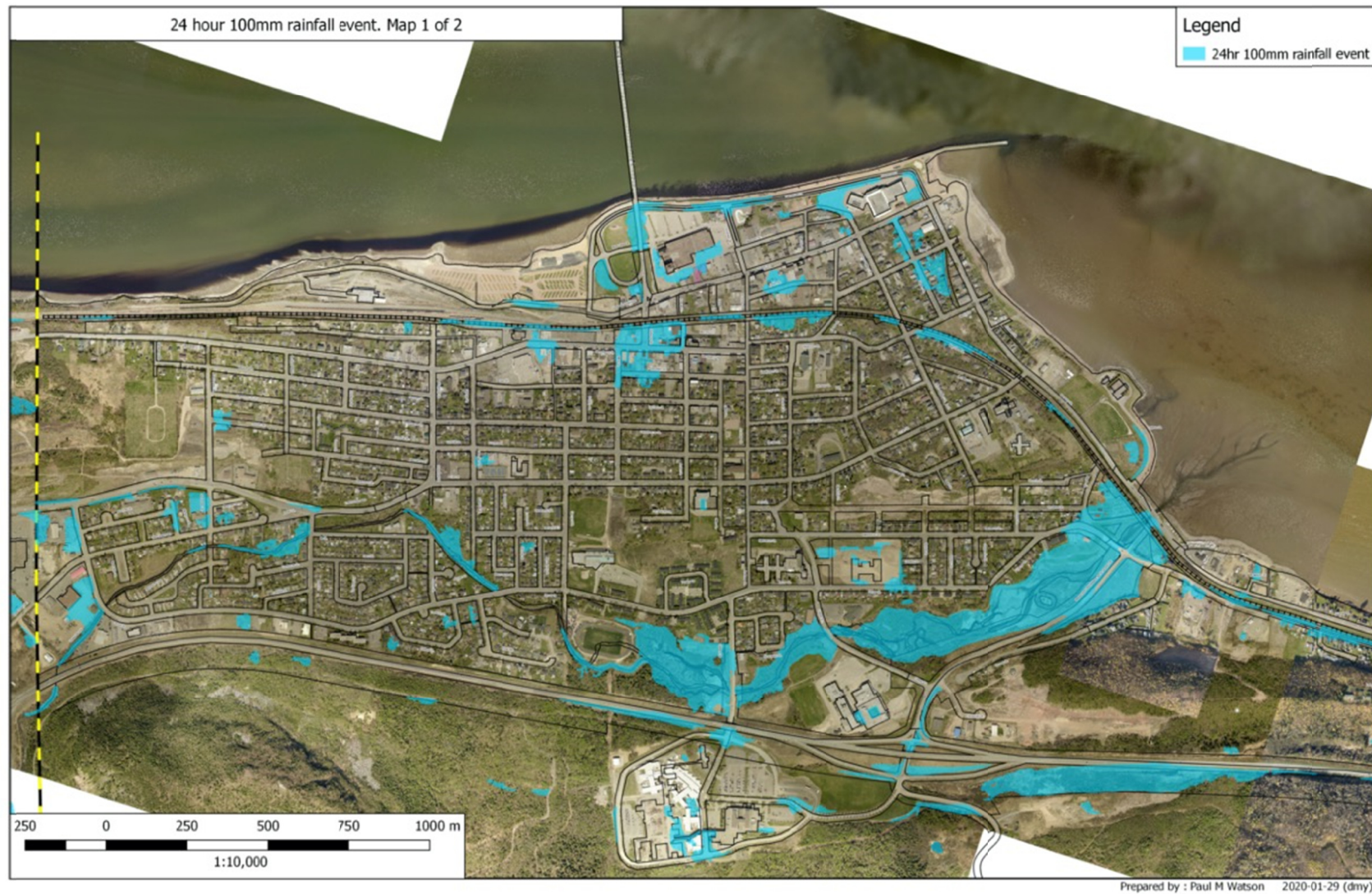
	Housing area		Offer backflow valve program, sump pump program (bulk install) Consider relocation of frequently impacted homes Raise buildings	provide education	Short-term Mid-term Mid-term
20	Waterfront electrical buildings	Low	Raise electrical units above flood risk height Relocate buildings and services if possible	City	Mid-term
21	Walker Brook	Medium- High	Promote and invest in establishing buffers along brook Prevent any further infill or buildings in flood zone Relocate low-lying buildings	City	Short-term Short-term Mid-term

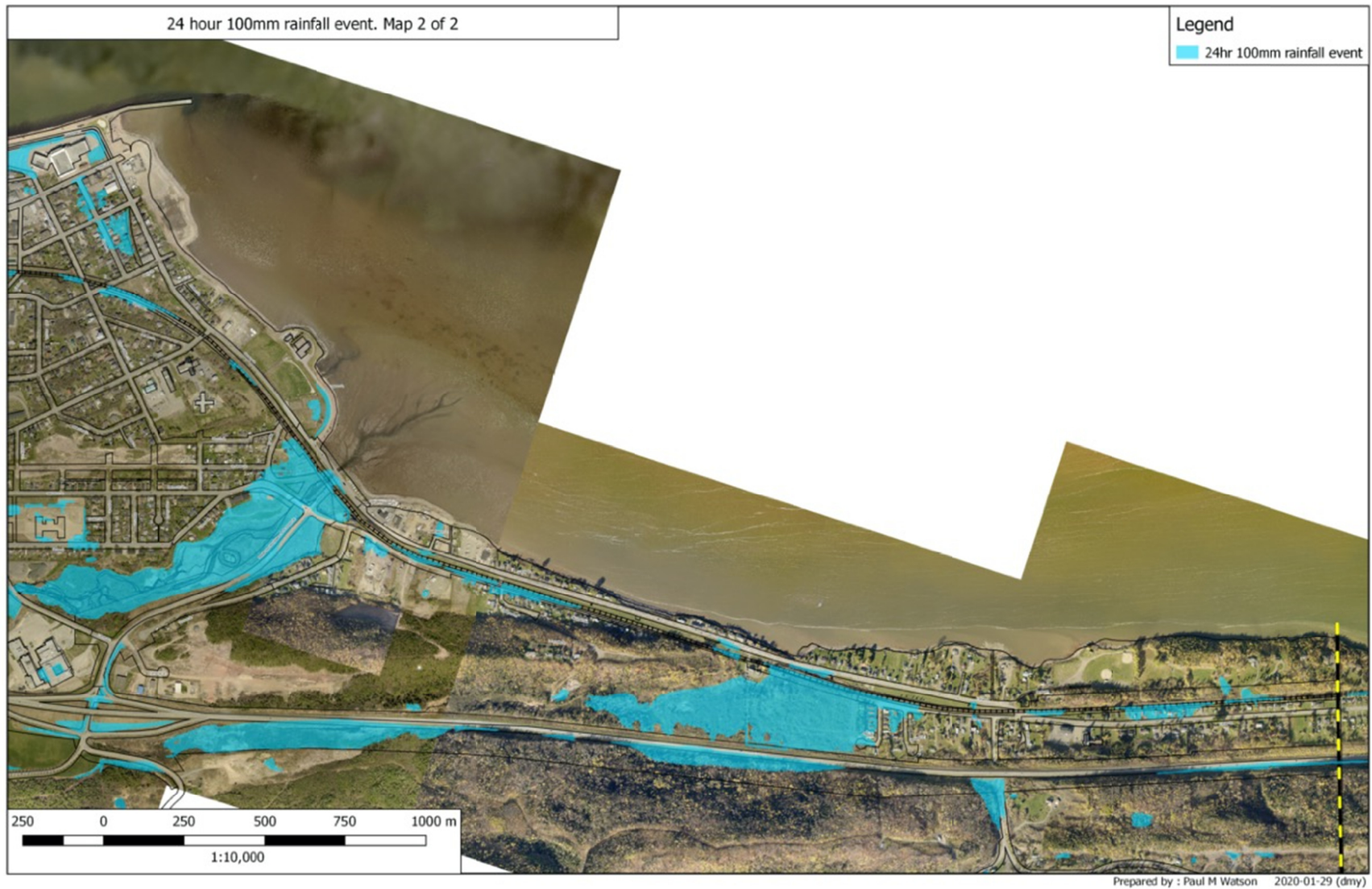
Appendix # 7 - Figure 3 a) & b) - Coastal Flood Risk Map for City of Campbellton





Appendix # 8 - Figure 4 b) & 4 b) - Depth to Water Table Map for City of Campbellton, projected flooding from a 100mm Rain Event in 24 hrs





Appendix # 9 - Figure 5 a) & 5b) - At Risk Locations in the City of Campbellton

