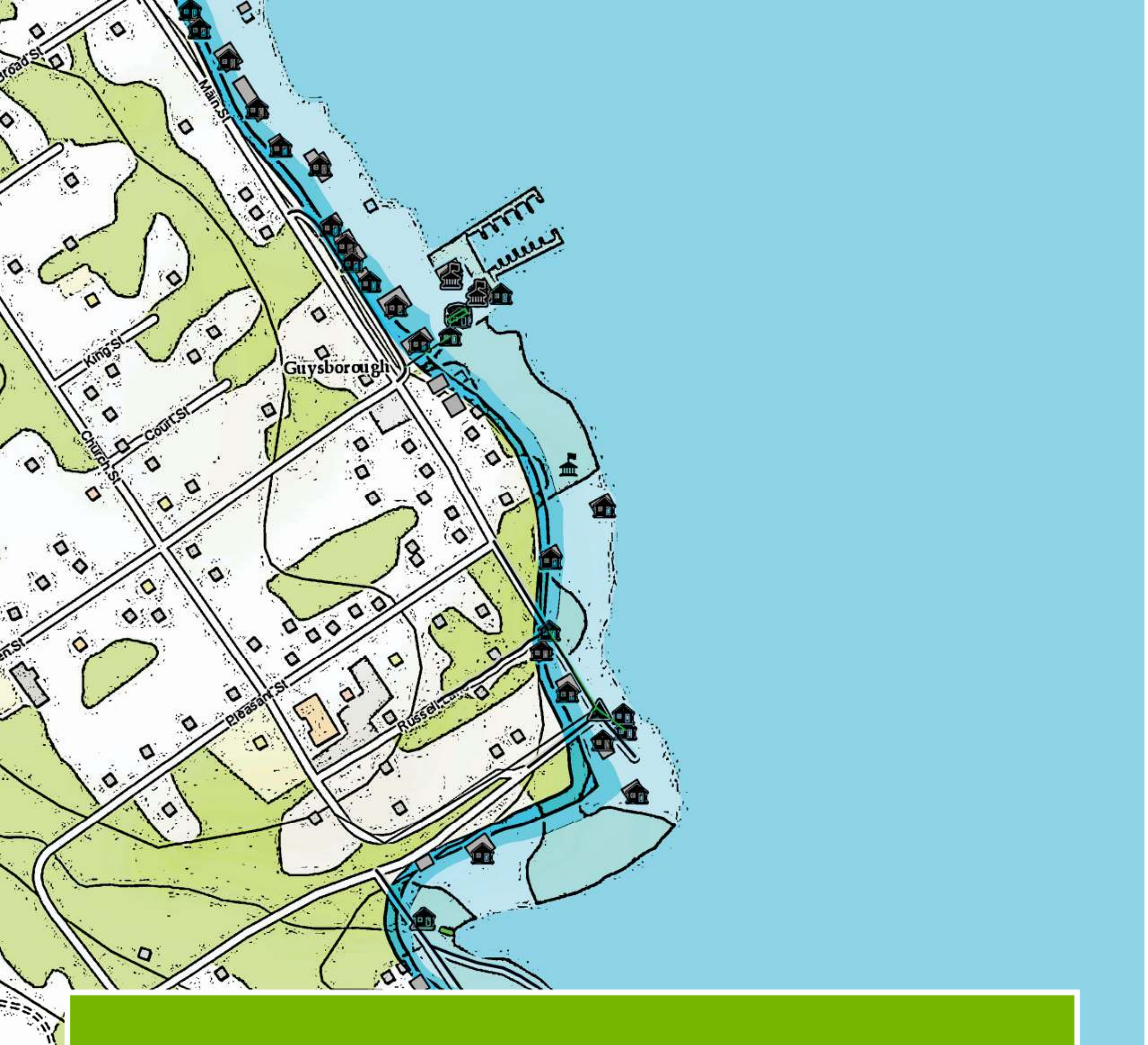

Climate Change Mitigation Plan

Municipality of the District of Guysborough

Final Report

191058.00 • Report • May 2020

	Final Report	Emanuel Nicolescu	08-05-2020	
	Draft report	Emanuel Nicolescu	04-03-2020	Lauren Fleet
Issue or Revision		**Reviewed By:**	**Date**	**Issued By:**

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May 8, 2020

Shawn Andrews
Director of Fire, Emergency & IT Services
33 Pleasant Street, Nova Scotia
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Dear Mr. Andrews:

RE: Municipality of the District of Guysborough Climate Change Mitigation Plan

CBCL is pleased to present the Climate Change Mitigation Plan for the Municipality of the District of Guysborough. The following report presents the Municipalities vulnerabilities as a result of sea level and coastal flooding. The plan also outlines mitigation and adaptation options to reduce or protect important municipal assets to the impacts of climate change and extreme weather. Preliminary flood mapping within the Municipality is provided including the GIS flood line and impacted asset files for ease of access. This plan is intended to aid the Municipality in resiliency to sea level and coastal flooding impacts as well as to provide a resource in the future planning and development decision making.

Yours very truly,

CBCL Limited

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Contents

Appendices

CHAPTER 1 INTRODUCTION

The increasing risks and costs associated with flooding, extreme weather, and climate change on public safety, human health, environment, and infrastructure resilience are at the forefront of municipal planning discussions. Climate change and extreme weather adaptation strategies are building the foundation for informed mitigation investments. The Municipality of the District of Guysborough (MODG) is seeking to identify and mitigate the impacts of climate change in the near and distant future by applying more accurate and informed decision making through implementation of a Climate Change Mitigation Plan (The Plan). In order to encompass the specific interests and main concerns of the Municipality, community stakeholders, residents, municipal council, municipal personnel and key agencies were consulted in the process of The Plan development.

Increasing community resilience to coastal flooding and extreme weather events will protect important economic, residential, environmental, cultural, and social infrastructure and assets in the near and distant future. The Plan presents flood risk mapping with regard to multiple coastal flooding scenarios including climate change and storm surge events obtained from the *Municipal Climate Change Adaptation Plan* (MCCAP) (Genivar Inc and Guysborough Climate Change Adaptation Committee, 2013). The mapping includes all identified municipal assets within the MODG. The Plan directly identifies and addresses the current and potential future risks and impacts related to coastal flooding and extreme weather events. The Plan involves a comprehensive risk and vulnerability assessment of coastal flooding and extreme weather events to the Municipality including:

- Human health and vulnerable populations
- Public safety and emergency services
- Municipal Infrastructure
- Local economy and economic activities
- Tourism and recreation
- Key local industry
- Development opportunities
- Local environment and ecology

The Plan also outlines specific mitigation and adaption measures in which to protect important infrastructure from the assessed impacts of coastal flooding.

1.1 Climate Change Adaptation

In the past, Canada has warmed at approximately two times the magnitude of global warming, this trend is projected to continue into the future (Bush E. a., 2019). Over the period of 1948 to 2016 Canada has experienced a mean annual temperature increase of 1.7°C (Bush E. a., 2019). Atmospheric warming is linked to changes in precipitation, sea level, inland water levels, sea ice, permafrost, and extreme weather events (Palko, 2016). Climatic variability is creating both opportunities and challenges for Canadian municipalities.

The MODG has received partial funding from the Government of Canada under the National Disaster Mitigation Program: Steam 3 Mitigation Planning, to better equip itself to the vulnerabilities of disaster risks and climate change. According to the Insurance Bureau of Canada, flooding incurs the greatest amount of financial damage and losses. Nationally, the insured losses related to flooding totalled $405 million between 1983 and 2008, and increased to a total of $1.8 billion between 2009 and 2017. Flooding related costs have quadrupled in 40 years and account for 40% of all the Disaster Financial Assistance Arrangements (DFFA) expenses. Furthermore, in 2018 the damage covered by insurance from extreme weather was approximately $2 billion (Insurance Bureau of Canada, 2019).

In the context of climate change, Nova Scotia has experienced rising average temperatures, higher intensity precipitation events, rising coastal sea levels, and amplified coastal erosion and flooding. Overall, climate scientists predict that Atlantic Canada will experience increasingly wetter, warmer, and stormier weather in the future (University of Western Ontario, 2015). The length of heat waves and hot spells is also anticipated to increase (Institute for Catastrophic Loss Reduction, 2016). Long stretches of extremely hot temperatures have not been common historically for the region, and therefore, impacts to vulnerable infrastructure may present new challenges.

Coastal flooding has been a main issue and concern for municipalities across Nova Scotia. The risk and vulnerability of coastal communities continues to rise with sea level. The intensity and frequency of extreme storms are projected to increase over the 21st century. Climate change can threaten the economic and social benefits of the costal environment as higher water levels and storm surge increases the risk of flooding and damage to coastal infrastructure and the increased frequency and intensity of storm events amplifies coastal erosion.

As a coastal municipality primarily settled along the shore, the MODG is directly linked to coastal areas, activities, and infrastructure. Due to the water-focused nature of main economic drivers such as the fishery and natural resources sectors, infrastructure is inherently located along the coast.

Tourism is an important aspect of the community, which hosts National and Provincial parks and campgrounds, trails, boardwalks, and beaches which may be vulnerable to the impacts of climate change such as erosion and sea level rise. Vulnerable populations in the MODG; including seniors and children depend on access to emergency care facilities which may be at risk of inaccessibility due to flooding or wash out of essential access roads. Adaptation measures to reduce the impacts of climate change will work to protect important municipal and community assets and guide planning for sustainable future development.

Despite many Canadian communities reporting vulnerabilities to climate change, adapting infrastructure and operations to a changing climate and emerging environmental conditions remains a relatively new area of focus for many sectors (Palko, 2016). Mitigation and adaptation are the national leading responses to climate change where:

- **Climate Change Mitigation** refers to actions related to greenhouse gas (GHG) emission reductions;
- **Flood Mitigation** refers to actions related to reducing flood risk; and
- **Adaptation** refers to any activity that reduces the negative impacts of climate change and/or takes advantage of opportunities created by climate change. This includes actions taken before impacts are observed (anticipatory), and after impacts have been felt (reactive).

CHAPTER 2 BACKGROUND

2.1 The Municipality of the District of Guysborough

The Municipality of the District of Guysborough (MODG) is located on the North Eastern tip of Mainland Nova Scotia as shown in Figure 2-1. The MODG is one of three municipal units in Guysborough County and borders the St. Mary's municipal district to the West, Antigonish County to the North and the Strait of Canso to the East, not including Mulgrave (see MAP). The MODG covers an area of approximately 2,200 km^2, with 400 km of coastline (Council of the Municipality of the District of Guysborough, 2017) of which approximately 44 km are under municipal control (Cunningham, 2010).

Source: http://www.municipality.guysborough.ns.ca/sites/default/files/images/map/map.pdf

Figure 2-1 MODG Municipal Boundaries and Study Area

According to the most recent 2016 Canadian census, MODG has a population of 4,670 people, equating a density of 2.2 persons per km^2. However, a majority of the communities are spread out along the provincial routes 16, 316 and 344, and along the coast (WSP Canada Inc., 2015). The median age of the population is 56.5 years as compared to the 45.5 years in the Province. A majority of the residents commute and travel by personal vehicle (WSP Canada Inc., 2015).

The main economic activities in the MODG include fishery, forestry, natural resources, and tourism. MODG is involved in the oil and gas industries, wind power generation, and run of the river hydroelectricity. The Municipality has access to highways, rails, an export pipeline and a deep water port. Due to the nature of main local industries such as the Martin Marietta quarry at Aulds Cove, and proposed projects such as the Vulcan Materials tidal quarry, the Melford Atlantic Gateway container terminal, and the Pieridae Energy LNG terminal, the projects require coastal locations with direct water access. Tourism is also an important aspect of the community and is directly linked to the natural environment. The Municipality hosts national and provincial parks and campgrounds, beaches and walking trails that draw in people in the summer months and throughout the year. (WSP Canada Inc., 2015)

Since 1996, the municipality's population has been consistently decreasing, mainly due to the lack of job opportunities (Council of the Municipality of the District of Guysborough, 2017). Economic development is therefore a high priority for the vitality of the municipality. The local government recognizes the benefits of a coastal location for the prospect of developing industrial projects and encourages this industrial development while safeguarding the natural environment. Future economic opportunities are linked to port development, such as on the Canso Straight, and focused towards wind energy, aquaculture, waterway terminals, petrochemicals, and industrial development (WSP Canada Inc., 2015).

The MODG offers a multitude of services that source the municipality as well as surrounding areas. These services include waste management, water services, fire services, and transportation. The Municipality is composed of many important infrastructure assets such as wharfs, residential properties, roads, bridges, etc. which are located within close proximity to the coast and vulnerable to the impacts of climate change, sea level rise and coastal flooding. The MODG has a number of historical, cultural and social assets important to the community such as churches, schools, community centres, parks, and protected environmental features and areas such as Black Duck Cove Boardwalks, Grassy Islands and Tor Bay Beach. The area has an abundance of natural resources and environmental assets including beaches, forests, coastal lowlands, and wildlife habitats (Genivar Inc and Guysborough Climate Change Adaptation Committee, 2013).

To identify and address the vulnerabilities of these assets to climate change driven risks, the municipality has undertaken a variety of sustainability, action, strategic and adaptation studies to ensure the current and future vitality of the community and become more informed to the inherent risks of climate change. Previous reports, as well as key infrastructure assets, are further described in Sections 2.2 - 2.4.

2.2 Previous Studies

A number of studies have been undertaken by the MODG in order to identify local risks and opportunities to develop sustainable and strategic planning tools for current and future development and community vitality. These studies are reviewed below.

Integrated Community Sustainability. Ashley Cunningham Sustainability Coordinator Municipality of the District of Guysborough.

Completed in 2010 in order to address sustainability issues of the MODG concerning environmental, economic, social, and cultural sectors. The Plan provides a detailed history and inventory and assessment of the municipality, and outlines municipal service agreements. The Plan assesses each subsector of the sustainability issues as detailed below, and provides development/ upgrades in order to meet sustainability goals. The main sustainability issues and the associated subsections are outlined as follows:

- **Environmental Sustainability** - Water and wastewater systems; solid waste management; municipal energy use; transportation infrastructure, and land use planning; and protection of biodiversity.
- **Economic Sustainability** - Economic success; regional development authority collaboration
- **Social Sustainability** - Emergency services; health services; recreation; affordable housing
- **Cultural Sustainability** - Heritage; tourism; arts and culture; regional development authority collaboration

Sustainable development goals and actions were identified and eligible projects for consideration and associated benefits were outlined within the Plan.

Municipal Climate Change Adaptation Plan. Guysborough Climate Change Adaptation Committee & Genivar Inc., 2013

As part of the Municipal Climate Change Adaptation Plan, the MODG established a climate change adaptation committee. The purpose of the plan was to identify and prioritize climate change adaptation actions to increase the resiliency of the community. Municipal assets and climate change events were identified, and categorized in five main sustainability themes; environmental, build, economic, cultural and social. The identified climate change impacts involve flooding scenarios within the MODG including expected sea level rise, high tide, and storm surge and land subsidence. Flood mapping depicting the identified seal level rise scenarios over topographical data along the coastline of Guysborough was provided to show areas vulnerable to the anticipated sea levels. A risk and impacts assessment was undertaken and a rating scheme was implemented to guide development of the identified actions.

Local Action Plan for the Reductions of Greenhouse Gas Emissions – Under the Partners for Climate Protection Initiative. Municipality of the District of Guysborough. WSP Canada Inc., 2015.

The MODG joined the Partners for Climate Protection program (PCP) in 2009. This program defines a process for municipal governments to quantify their GHG emissions and then develop and implement action plans that can achieve emission reductions. As part of the initiative, the MODG completed the first milestone of the process in December 2014 by creating a greenhouse gas corporate and community inventory. A Local Action Plan was completed in 2015 as another milestone achieved in the initiative. The plan outlines a number of projects to be implemented in order to reduce energy consumption, increase the use of renewable energy and reduce the use of fossil fuels, and encourage energy efficiency.

MODG 2017-2022 Strategic Plan. Municipality of the District of Guysborough 2017.

The purpose of the *Strategic Plan (2017-2022)* was to provide a framework to organize and align the municipality’s activities with a clear focus for the future. The Plan provides four broadly defined, long-term, strategic goals which extend beyond the five-year strategic plan period and which guide all actions of MODG (people, prosperity (focusing on employment and commercial and industrial development), infrastructure, and environment). The MODG identified strengths, weaknesses, opportunities and threats to be further analyzed while developing the municipality's strategic plan. Tourism was identified as a potential sector for significant growth for the Municipality and the aging/ declining population was identified as the main challenge.

2.3 Nova Scotia Coastal Protection Act

The Nova Scotia Coastal Protection Act – Bill 106 (CPA) is new legislation enacted in 2019 per platform commitments from the Provincial government. The information herein was gathered from the Act itself as well as from a phone interview with John Somers from Nova Scotia Environment (Somers, 2019). The Act was developed based on the increasing identification that sea-level rise, coastal flooding, storm surge and coastal erosion pose significant threats to the safety of future development in coastal areas. The purpose of the Act is to protect the provincial coastal environment by preventing development and activity in locations that damage the environment by interfering with the natural dynamic of the coast and put residents and buildings at risk from sea level rise, coastal flooding, storm surges and coastal erosion.

The Act has not yet been proclaimed into law and will come into effect once regulations are approved by the Governor in Council. Consultation will be undertaken with municipalities and the public approximately mid-2020, although this time line may be pushed back on account of current restrictions imposed by COID-19. The Act has been undertaken in parallel to the Province's Municipal Flood Line Mapping project, which aims at producing flood mapping according to standard methods and guidelines for the entire Province. The CPA defines a Coastal Protection Zone (CPZ) which will include areas immediately adjacent to the ordinary high-water mark on both the seaward and upland sides. The dimensions of the CPZ have not yet been determined.

In addition to regulations protecting sensitive coastal ecosystems, parts of the CPA are focused specifically on reducing coastal erosion and inundation risks by prohibiting the issuance of municipal building permits for locations within the CPZ unless they are compliant with the Act and regulations.

Delineation of the Coastal Protection Zone will be determined based on a vertical setback to reduce the risk of inundation, which will be prescribed in regulation and expressed as a minimum building elevation. A horizontal setback will prescribe a minimum horizontal distance from the ordinary high-water mark, based on an assessment of site-specific coastal erosion risk factors as certified by a Designated Professional following a prescribed methodology.

The horizontal setback may have significant implications on properties and buildings, therefore higher tolerances may be accepted for the horizontal setback. A main purpose of this setback is to defend coastal erosion. The vertical setback will be defined as a hard elevation from the average sea level. The elevation may be determined based on projections of sea level rise, tidal amplitude and a freeboard and allow a minimum building elevation to be set through Municipal Affairs and Housing. The CPA prescribes the vertical elevation; while allowing municipalities to enact more stringent protections, but is averse to reduced elevations. The main purpose of this setback is to protect against saltwater intrusion and inundation. At the time of this assessment, three municipalities have enacted vertical setbacks; Cumberland Country; Halifax Regional Municipality; Areas of Lunenburg County.

The Act states that no persons may construct, modify or locate a structure in the Coastal Protection Zone unless the construction, modification or location of the structure is in compliance with this Act and its regulations. The coastal erosion risk assessment will rate the risk of erosion based on land contour, geological condition, and wave exposure. A construction permit cannot be granted if the proposed development is not compliant with the purpose and principles of the Act. A certificate will be required stating the development poses low risk according to the provincial methodology in regards to the Act. A Request for Proposals is currently open for the Development of A coastal Erosion Risk Factor Assessment Standard. The qualifications for being a Designated Professional will be prescribed in regulations which are currently under development. While the exact qualifications have not yet been determined, individuals may need to be a member in good standing of one or more identified self-regulating professional bodies and possess relevant experience. Designated Professionals will likely be required to "self-declare" as being competent to complete the work, and as being a member in good standing of their respective professional body. Laws governing their respective professional bodies and scope of practice will apply.

Professions currently under consideration to be designated under the CPA include engineers and geoscientists with experience in geotechnical engineering, civil engineering, geomorphology, coastal engineering and similar fields. Designated Professionals (DP) will be responsible for meeting the regulatory requirements to act as a DP and make a declaration to this effect when certifying a coastal erosion risk factor assessment.

The Act includes certain exemptions such as; agricultural activities (marsh bodies and dykes), public infrastructure, industrial and commercial activity requiring direct access to water as a functional part of the business plan and shoreline structures placed by Lands & Forestry.

2.4 Municipal Assets

The MODG provided GIS files of all assets inventoried within the municipality. Total assets within the municipality derived from the provided GIS files are quantified and organized by category in Table 2.1 below.

Table 2.1 Summary of Municipal Assets

Asset	Total in MODG
Infrastructure	
Wastewater Treatment Plant	5
Water Treatment Plant	1
Lift Stations	10

Roads	328
Canso Fire Hydrants	52
Buildings	6290
Properties	22741
Nova Scotia Civic Address Files in Guysborough	4345
Manholes	32
Leases	5
Economic	
Wharfs	20
Alternative Power	14
Leases	5
Cultural	
Schools	2
Museums	3
Churches	39
Community Halls	36
Recreational Facilities	19
Playgrounds	12
Comfort Centers	16
Environmental	
Parks	23
Municipal services	
Emergency Health Services	3
Emergency Operations Center	2
MODG Offices	4
RCMP Station	2
Fire Stations	13

Additional datasets were accessed via the Open Data Nova Scotia, and GeoNova services to ensure that all important municipal assets were accounted for within the Flooding Analysis. Open Data Nova Scotia is an open data portal managed by the Government of Nova Scotia to provide easy access to important provincial data for individuals, researchers and businesses. The topographic data base provides GIS files with complete inventories of categories including designated areas, roads and railroads, structures, utilities, and buildings across all of Nova Scotia. Extracted layers for assessment were selected in order to both compare against important asset layers provided by the municipality (roads, buildings etc.) for accuracy and also to expand the scope of evaluated assets. The assets extracted from Open Data Nova Scotia for further analysis within the MODG are listed in Table 2.2.

Table 2.2 Summary of Provincial Infrastructure Assets

Open Data Asset	Open Data Descriptor
Buildings	

Culverts	
Roads	Roads
	Railroad lines
	Railroad overhead
	Tracks
	Trails
Bridges	
Utilities	Pipeline
	Transmission line
	Tower
	Tanks
	Sewage Setting Pond
	Substation
Designated Areas	Campground
	Parking Area
	Park
	Cemetery
	Ferry Terminal
	Golf course
	Heliport
	Sports Field
	Storage Area
	Quarry
	Lumber Mill
	Sewage Treatment Plant

Previous reporting within the MODG provided a strong background of identifying municipal assets, services, future development plans as well as providing insight into the focuses and priorities of the community and local government.

2.4.1 Economic Assets


Source: https://en.wikipedia.org/wiki/Aulds_Cove

Current and future economic sustainability and development is the foremost priority for the municipality. The MODG strongly encourages business and industrial development while ensuring the protection of the natural environment. The municipality's coastal location has been identified as an important asset providing many advantages and opportunities for industrial developments and projects. Currently, the economic landscape of the MODG is primarily linked to the natural environment. Primary economic assets include a sustainable fishery, aquaculture, aggregate and minerals, forestry, and tourism. The MODG participates and is competitive in the oil and gas industries, hydroelectricity, and wind power generation. The municipality has access to highways, rails, an export pipeline, a deep water port including the Strait of Canso, which allows for a strong potential of coastal industrial development.

A primary industrial driver includes the Martin Marietta Quarry at Aulds Cove. Located in the Strait of Canso adjacent to the Canso Causeway, this Quarry is a producer of aggregates for mainly concrete and asphalt building materials and provides a source of jobs within the MODG (Martin Marietta, 2020). The Sable wind project was designed by CBCL and developed in partnership with Nova Scotia Power. The project and is a 13.8 MW wind farm located near Canso and Hazel Hill in the MODG. The wind farm was part of an objective to contribute to the provinces renewable energy goals (WSP Canada Inc., 2015).

Future economic plans and opportunities involve port development and include the current proposed projects such as Melford Atlantic Gateway Terminal, the Vulcan Materials Tidal Quarry, and the Pieridae (Goldboro) Energy LNG terminal. The Melford Atlantic Gateway Terminal is a 315 acre container terminal and intermodal rail facility (WSP Canada Inc., 2015). The site is located on the Strait of Canso which is a deep ice free harbour supporting multiple liquid and dry bulk marine terminals. The terminal will aim to optimize loading and unloading of large container vessels, emphasizing direct vessel to rail transfer. The Melford Atlantic Gateway will be the closest port to Europe and Asia (via Suez). The project includes a logistics park and will rely on highway and rail services for operation (SSA Marine, 2020).

The Vulcan Materials Blackpoint Tidal Quarry project has been approved with conditions by Environment Nova Scotia at the time of this assessment. The proponent of the project is Black Point Aggregates Inc. The project site is located at Black Point, Guysborough Country, Nova Scotia. The project involves 250 million tons reserve of high quality aggregates (WSP Canada Inc., 2015) and is projected to produce 7.5 million tonnes of granite per year with an expected mine life of approximately 50 years. Additionally, the project proposed a 200 meter-long marine terminal and loadout facility adjacent to the quarry in Chedabucto Bay (Government of Nova Scotia, 2018).

The Pieridae (Goldboro) Energy LNG terminal is proposed to be the East Coast of Canada's liquefied natural gas export facility. Existing pipeline will export Canadian natural gas supplies to Goldboro, Nova Scotia to be shipped to international markets. This project has been defined as the largest mega-project in the history of Nova Scotia. It is projected that the project will generate 3,500 jobs during the construction phase and produce 200 permanent jobs to operate the facility. The plant will be located at the mouth of the Maritimes northeast pipeline in Goldboro, Nova Scotia. At the time of the assessment, the proposed project includes two liquefaction facilities together producing 10 million tonnes of LNG each year. Construction of the terminal is expected to commence in 2020 (Pieridae, 2018).

Additionally, future industrial projects will be encouraged through the proposed development of the Goldboro Industrial Park (WSP Canada Inc., 2015). The light industrial park is envisioned to be established in the area of the Municipality's 2nd Generation landfill site, located off Route 16 on Meagher's Hill, between the Communities of Boylston and Lincolnville (Council of the Municipality of the District of Guysborough, 2017). Petrochemical facilities, co-generation plants and wind farms are additionally identified areas of future development within the MODG. Finally, the Community of Guysborough has been identified as the primary growth center for the municipality (Council of the Municipality of the District of Guysborough, 2017).

Furthermore, aquaculture has been identified as an industry with significant growth potential within the MODG. The MODG is host to many wharfs along its coastline that work as shipping docks to load and unload cargo and passengers. Coastal locations provide access and availability of water and are required due to the nature of these current and proposed developments.

The MODG is host to a variety of provincial and national parks and campgrounds. Salsman Provincial Park located along route 316 near Middle Country Harbour and Boylston Provincial Park located along Route 16 between the communities of Boylston and Guysborough are popular campground and tourism destinations in the summer months. Tourism is an important economic aspect of the community which works to draw in people, generate employment and simulate the economy and boost wide scale industry revenues.

2.4.2 Municipal Assets

Source:
http://www.municipality.guysborough.ns.ca/residents/news/surpluswastecollectiontruck

The MODG provides a number of important services for the municipality and surrounding communities. According to the Integrated Community Sustainability Plan, the Municipality accepts solid waste from 17 Municipal units throughout Northeastern Nova Scotia. In total, there are five wastewater treatment plants and ten associated lift stations. The municipality operates one water treatment plant as well as the Hazel Hill - Canso Water Utility. Currently, a sewer system is in the Shiretown of Guysborough. Municipal sewer service is available in the Communities of Little Dover, parts of Hazel Hill and Canso and Municipal water service is provided in Hazel Hill, Canso and Tickle.

The district is served by twelve (12) volunteer fire departments that provide fire suppression services, medical emergency first response and vehicle extrication. Three of the department's service areas are located outside of Municipal boundaries; Aulds Cove Volunteer Fire department services areas in Antigonish County; Goshen & Area Volunteer Fire department services parts of the Municipality of the district of St. Mary's; and the Tracadie & District Volunteer Fire department serves areas of Antigonish County (Cunningham, 2010).

The MODG provides emergency health services and operates an emergency operations centre. There are a number of government offices and RCMP stations within the municipality. The MODG owns two public roadways; Sable Road in the Goldboro area and the other leading to the MODG Waste Management Facility. The MODG is responsible for the maintenance and upkeep (50% cost share with Province of NS) of 15.11 km of J-Class roads within the MODG. There is no public transportation provided within the municipality. Additionally, the Canso Causeway and Country Harbour Ferry are important modes of transportation within the Municipality.

2.4.3 Cultural Assets

Source: https://commons.wikimedia.org/wiki/File:St_Ann%27s_Catholic_Church,_Guysborough.jpg

Guysborough was originally founded in 1636, and since then has retained many important cultural and historical assets. Museums, including the Old Court House museum, preserve much of the community's rich history. The MODG sustains many churches, cemeteries, and historical sites such as Canso Islands, Grassy Island, Tor Bay Beach and Priests Island. Beaches, parks, trails, and waterfronts such as the Black Duck Coves boardwalks, are essential aspects of the community. The municipality upholds a strong community culture through a number of recreation facilities, comfort centres, community halls, schools, parks and playgrounds.

2.4.4 Environmental Assets


Source: https://www.granfondoguysborough.ca/header_granfondo_1800x331px_beach/

The MODG is host to many environmental assets including; beaches, forests, wetlands, coastal lowlands, protected areas and wildlife habitats. These environmental aspects make up a large portion of the landscape within the MODG and are priority of the local government to preserve. There are four provincially and nationally identified species at risk located in the MODG: the Roseate Tern, the Moose, the Wood turtle and Boreal Felt Lichen. Wilderness areas including: the Bonnet Lake Barrens, the Ogden Round Lake, and the Canso Coastal Barrens sustain the natural environmental richness of the community. Provincial parks and beaches including: Boylston, Tor Bay, Black Duck Cove, Port Shoreham, Fox Island, and Salsman Provincial Park are significant assets. The coastline and its associated rich environmental features is a major asset to the municipality.

2.5 Scope and Methodology

Managing flooding and extreme weather impacts through a systematic, risk based process provides policy-makers and decision-makers with a tool to identify and prioritize risks/vulnerabilities, and to execute immediate or long term actions that meet stakeholders' needs. Priority risks, identified through an understanding of the likelihood of occurrence and consequence of a future climate event, are brought forward to the mitigation planning process to determine strategic and practical adaptation strategies.

The scope of the project is the development of a plan to mitigate coastal flooding challenges within the MODG and provide a guide for sustainable future development. The plan will identify and assess economic, social, environmental, cultural and infrastructure assets within the municipality vulnerable to coastal flooding. This assessment also includes a review of existing bylaws, strategies, plans, policies and report documents including the new Coastal Protection Act. A first step in an effective flood management strategy is to identify and understand the flood risks facing the municipality. This entails an understanding of the floodplain now and in the future, considering SLR scenarios and increased chances of extreme events and storm surges. A risk assessment is completed on the vulnerable assets in order to determine impacts and to prioritize adaptation strategies; this is done through a consequence and likelihood assessment. Finally, mitigation and adaptation options are identified and outlined within the plan.

CHAPTER 3 FLOODING ANALYSIS

Source: https://www.cbc.ca/news/canada/nova-scotia/storm-surge-atlantic-coastline-1.4561552

Coastal flooding has impacted municipalities across the province and has been a growing concern for local governments. Atlantic Canada is primarily impacted by two types of severe storm events: tropical cyclones and Nor'easters. The risk and vulnerability of coastal communicates continues to rise as sea levels increase under a warming climate, and the intensity and frequency of these and other extreme storms are projected to increase. Climate change can threaten the economic and social benefits of the costal environment. Higher water levels and storm surge increases the risk of flooding and damage to coastal infrastructure and the increased frequency and intensity of storm events amplify coastal erosion.

Coastal Flooding is a result of storm events which generate extreme water levels and wave run-up, as well as sea level rise. Coastal flooding is a combination of the astronomical tide, storm surge, and sea level rise. In general, low-lying and unprotected coastal areas are the most vulnerable to flooding impacts. Guysborough is particularly vulnerable to flooding and sea level rise in low-lying areas such as beaches, estuaries, and wetlands. Many of Guysborough's historical, cultural, ecological, industrial and municipal infrastructure assets are located along the coast.

3.1 History of Flooding

There is a documented history of flooding within the MODG. Anecdotal flood events were provided by the municipality and outline the conditions and impacts of recorded extreme storm and flooding events. The major storm events resulting in significant flooding are presented in Table 3.1 with the associated year and season of occurrence as well as a description of the event. The location of the associated flooding events are outlined in Figure 3-1.

Table 3.1 Anecdotal History of Flooding Events in Guysborough

ID	Year	Season	Event Description
101	2001	Spring	Late spring storm of 2001, combined with massive snow melt caused a 40' section of roadway to be destroyed leaving the road impassable for weeks. This a tributary feeding the beginning of the Milford Haven River. It has only happened once in recent history.
102	2010	Winter	Near the mouth of the Milford Haven, much like Highway 16 near Guysborough, this area seems to be getting worse for damage. All of the storms that affect the other area described on Highway 16 near Guysborough affects this area. The worst damage was from the New Year's Storm in 2010 where it actually moved 3 fishing sheds along the shore and cause the Highway to be shut down. Again, this is the major highway running through the Municipality
103	2015	Winter/Spring	The beginning of the Milford Haven can see flooding, ice cake and be impassable for days. Thankfully, no one lives on this road. Having said that, the area in red is the hardest hit and lowest area. Most recently, as the Fall of last year, this was flooded with storm surge water for a couple of days. In the Winter/Spring of 2015, ice cakes 2 feet thick covered the entire road as a result of a strong storm and breakup.
104	2017	Winter	Hortons Cove Road is very prone to Spring Flooding and ice cakes. This is off of the Salmon River and most recent as the Christmas Storm of 2017, was not passable for a few hours due to the flooding and ice cakes. It is very close to the river, but generally protected. Conditions must be perfect for issues to arise, but they seem to be perfect more and more frequently.
105	2015	Winter	Referred to locally as the Long Beach, near Guysborough, at the mouth of the Milford Haven. During a winter storm in February 2015, this was the first time this beach was breached, and from the picture, you can see, eaten away in the centre, and has remained in that state since. Locals could not remember the last time that was in this state, if ever. The gap appears to be widening with each storm.
106	1996, 2003, 2010	Winter/Fall	Area on Highway 16, near Guysborough that sees flooding and wave action, depending on tide, very often with every storm now. Worst times at this location were Hurricane Hortense in 1996, Juan, 2010 New Year's storm, to name a few notable storms. This is the major road through the Municipality.

ID	Year	Season	Event Description
107	2000 2001	Winter	Major Storm in winter, 2000 or 2001, caused extensive damage in the Municipality, including a park, not in the scope of this project. DFA claim was opened for this particular area, but no damage has occurred since that storm. This area experienced flood damage to crops and livestock.
108	2018	Winter	Flooding on Storm, Feb 5, 2018, (I have other pictures). First time this area had flooded and close to a road closure and loosing bridge on the road. Ice and snow with heavy rain creating the scenario for flooding.
109	2010	Winter	Salmon River Beach, last number of years has grown in height from wave action. Winter storm on New Year's, 2010 saw the first time waves rolled over the beach. Have not seen that since that storm but beach seems to be getting wider and higher with each large storm.
110	N/A	Spring	Area on the Salmon River prone to ice dams and flooding in Spring. Mainly years with cold winters to allow then large rain events in Spring. Been close to an evacuation of the residents a few times as ice cakes have landed in the yard. Happens once every 5 to 10 years.

It is noted that a significant portion of the major storm events recorded have occurred during the winter and spring months. Snow melt, spring fresh, and icing has been cited in many instances as the cause of localized flooding and damage. Milford Haven, Hortons Cove Road, the inlet of the Salmon River, and Highway 16 near Guysborough are noted to experience frequent flooding events as well as observed impacts.

It was reported that in recent year's areas which had historically not experienced flooding have been observed to flood during large storm events. More recently, water has been noted to inundate further inland then historically measured heights, such as on the Salmon River Beach. Flooding of assets such as roads, bridges, beaches, and infrastructure has occurred and long term impacts such as erosion have been observed. A significant storm surge height of 1.5 meters was recorded in Halifax during Hurricane Juan. Most recently, Hurricane Dorian caused severe flooding and coastal damage when it tracked up the East coast in fall of 2019.

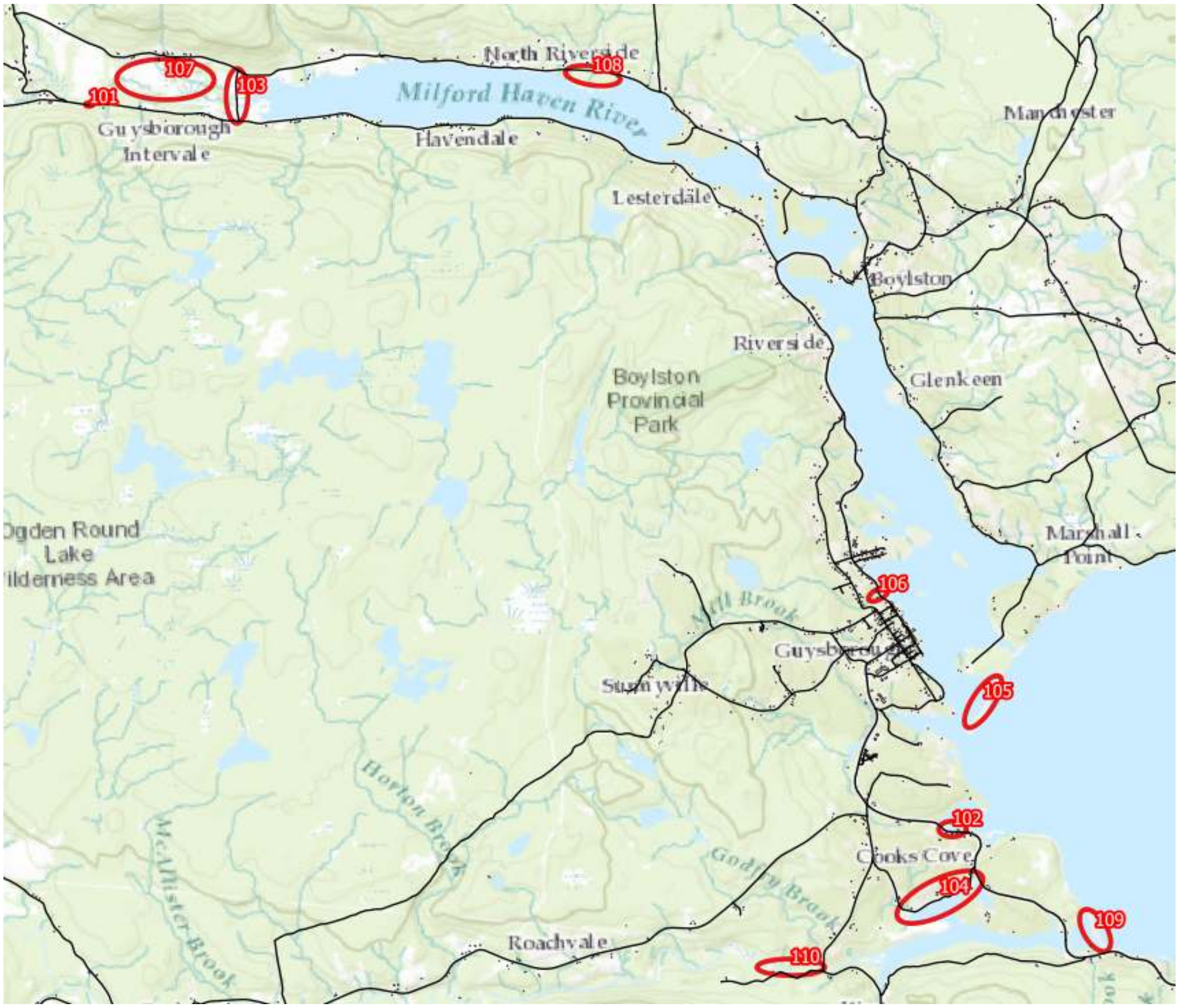


Figure 3.1: **Anecdotal History of Flooding Event Locations**

3.2 Flooding Scenarios

Flood mapping was produced for the MODG as part of the 2013 Guysborough Municipal Climate Change Adaptation Plan (MCCAP). It is noted that the datum was not specified for the flood elevations presented within the report. It was determined through a comparison to other reports that the flood elevations presented are relative to chart datum (CD). The maps produced in the 2013 MCCAP depict four possible water level scenarios along the Guysborough coastline. Each scenario increases in severity based on the intensity of the event. The three flooding scenarios used for the vulnerability assessment presented in this Mitigation Plan are shown in 3.2 on the following page. The elevations presented in Table 3.2 represent the associated sea level water level for each flooding scenario. Extreme water levels are measured as the sum of:

- Mean Sea Level
- Tides
- Sea-Level Rise (SLR)
- Storm Surges (meteorological effects such as low atmospheric pressure)
- Wave Run-up (vertical distance a wave travels up the shoreline above the still water level).

Table 3.2 MCCAP Sea Level and Coastal Flooding Scenarios

Flood Scenario	Sea Level Rise and Coastal Flooding Scenarios	Elevation (m – CD)
1	Mean Sea Level + Expected Rise/ Subsidence	2.58
2	High Tide + Expected Rise/ Subsidence	4.25
3	High Tide + Expected Rise/ Subsidence + Storm Surge	5.75

Flood scenarios 1 and 2 represent future sea level rise (during different tidal cycles) and flood scenario 3 represents an extreme water level during a storm event. Wave run-up was not included in the 2013 MCCAP and therefore was not part of the assessment.

The floodlines represented on the 2013 MCCAP report flood maps were derived by overlaying calculated flood elevations onto the 1:10,000 Provincial topographic mapping. Although not ideal for flood mapping, this course grained terrain data was the best available at the time the maps were produced. Therefore, it is noted within the report that several assumptions were made to accommodate the generality of the elevation data. The MCCAP report also notes that significant coastal cliff walls are present along the Guysborough coast, as a result the impact of coastal flooding may be minimized in some areas than what is depicted on the maps. Refer to Section 5.1 for the application of flood elevations and floodlines in the evaluation, design and implementation of flood mitigation efforts outlined in Chapter 5.

The recorded and projected sea levels used to generate the flooding scenarios are outlined in Table 3.3 below. The expected sea level rise value was projected to the year 2100.

Table 3.3 Water Levels from MCCAP 2013

Sea Level Values	Elevation (m – CD)
Mean Sea Level Today	1.08
Maximum High Tide Today	2.08
Expected Sea Level Rise 2100 (accounts for subsidence of 15 cm/century)	1.45

An extreme water level was determined in the 2013 MCCAP by adding a 1.5m storm surge residual to the sea levels presented in Table 3.3 above. A 1.5 m storm surge residual was recorded in Halifax during Hurricane Juan in 2003. Due to the estuary environment surrounding the Guysborough inlet, it is expected that this is a very conservative storm surge residual for the area.

The sea levels presented in Table 3.3 were compared to the most recent localized data from the Canadian Extreme Water Level Adaptation Tool (CAN-EWLAT) at the Queensport, NS station which is the closet and most representative station for the MODG (Government of Canada, 2016).
In summary:

- The Mean Sea Level and Expected Rise (MRSL) RCP8.5 represents the most conservative projected sea level rise in the region and was used for the 2100 sea level rise estimate comparison.
- The maximum high tide value reported in the MCCAP was compared to the most recent 2019 tide tables reported by the Department of Fisheries and Oceans (Fisheries and Oceans Canada, 2019).
- The storm surge value of 1.5 m, recorded during Hurricane Juan in 2003, was compared to best available storm surge data across Nova Scotia (Bernier, 2006) and is seen in Figure 3-1.

Table 3.4 compares the sea level data used to generate the floodlines within MCCAP 2013 report to the best available and most recent sea levels and projections. In each case the sea level elevations used to generate the floodlines applied for the vulnerability assessment either exceed or are comparable to the more recent data. Therefore, it was determined that the flood line elevations produced within the MCCAP 2013 were applicable for use in the vulnerability assessment.

Table 3.4 Sea Level and Coastal Flooding Comparison

Sea Level Values	2013 MCCAP Elevation (m – CD)	Most Recent Sea Level and Coastal Flooding Data	
		Elevation (m – CD)	Source
Mean Sea Level	1.08	1.02	(CAN-EWLAT), Queensport, NS
Maximum High Tide	2.08	2.1	DFO Tide Tables 2019
Expected Sea Level Rise to 2100 *(accounting for subsidence of 15 cm/century)*	1.45	0.91	(CAN-EWLAT), Queensport, NS
Storm Surge	1.5	0.8	Bernier et Al. 2006

According to the MCCAP 2013 the source data for generation of the flood mapping as well as referenced sea level rise reports are listed below:

- W. Richards, 2011: Scenarios and Guidance for Adapting to Climate Change and Sea-Level Rise.
- Department of Fisheries and Oceans Tidal Station #490 (Halifax) Data
- Coastal Sensitivity to Sea-Level Rise, Atlas of Canada
- The State of Nova Scotia’s Coast Technical Report, 2009
- Water Modeler: A Component of a Coastal Zone Decision Support System to Generate Flood Risk Maps from Storm Surge Events and Sea Level Rise from Geomatica 2008
- Service Nova Scotia 1:10,000 digital topographic services
- Municipality of the District of Guysborough

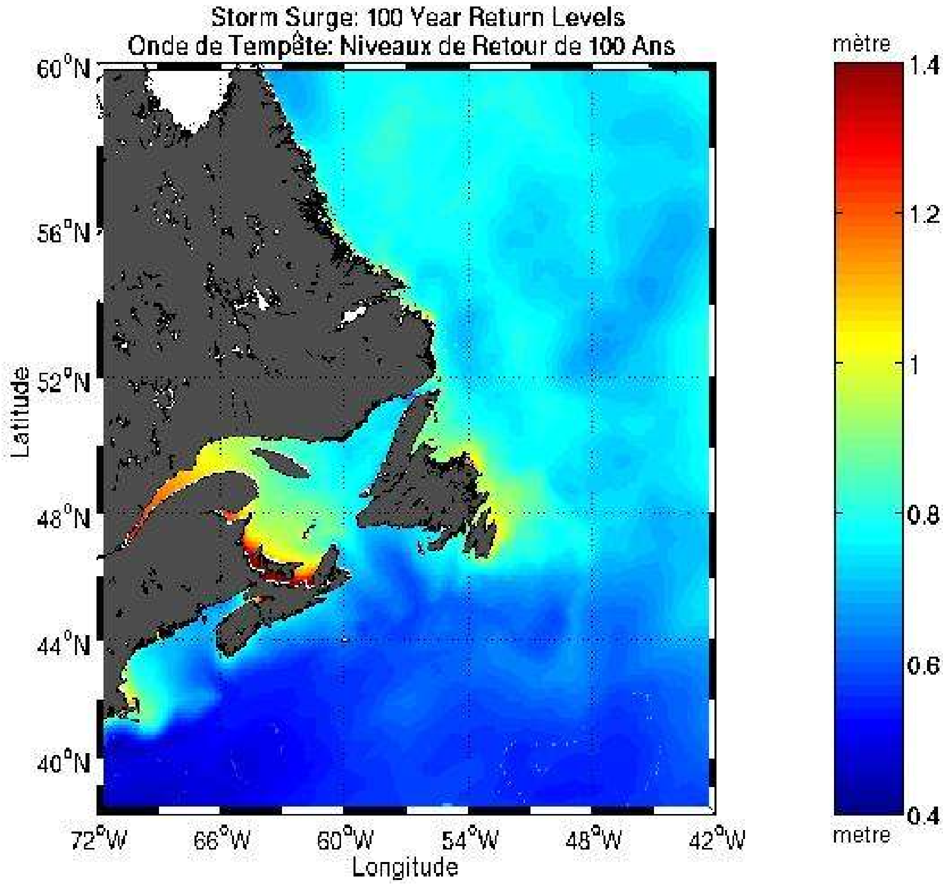


Figure 3-1 Storm Surge: 100 Year Return Levels

3.3 Flood Analysis and Mapping

A flooding analysis was performed in order to identify vulnerable municipal assets within the MODG impacted by each sea level rise event. Flood Maps depicting impacted assets is attached in Appendix A.

The identified municipal assets, as outlined in Section 2.3, were layered over the provided floodlines (Genivar Inc and Guysborough Climate Change Adaptation Committee, 2013) within ArcGIS. A 30 meter buffer was assigned to each flood line during the impact assessment to provide a margin of error due to the coarseness of the topographic mapping and outdated coastal water level data. Each flood line elevation was individually intersected with the asset layers to identify the impacts of each sea level rise flooding event. An asset was deemed to be impacted and vulnerable to the flooding event if it was at or below the elevation of the flood line. An inventory of the total number of assets impacted by each sea level rise scenario are categorized in Table 3.5. The vulnerability and risk of these assets is further assessed in Chapter 4 *Risk and Vulnerability Assessment*.

Table 3.5 Inventory of Vulnerable Municipal Assets

Asset	Total Number of Assets Impacted by Flooding Scenario		
	MSLER*	HTER**	HTERSS***
Environmental			
Parks	14	14	16
Beaches	4	4	4
Trails	20	20	24
Tracks	163	202	257
Infrastructure			
Buildings	997	1371	1821
Roads	387	448	541
Properties	3343	3705	4162
Nova Scotia Civic Address Files in Guysborough	550	794	1086
Railroad Lines	7	7	7
Railroad Overheads	2	2	2
Bridges	32	38	47
Country Harbour Ferry Terminal	1	1	1
Culverts	99	112	152
Substation (transformer)	1	3	4
Manholes	10	7	5
Pipeline	2	2	2
Transmission Line (electrical)	4	4	6
Tank (6-15m diameter)	3	3	3
Tower (all except transmission line towers)	5	5	6
Canso Fire Hydrants	6	10	17
Leases	1	1	1
Heliport	1	1	1
Economic			
Wharfs	20	20	20
Martin Marietta Quarry at Aulds Cove	1	1	1
Pieridae Energy LNG Terminal	1	1	1
Vulcan Materials Tidal Quarry	1	1	1
Melford Atlantic Gateway Container Terminal	1	1	1
Campground	2	3	3
Lumber Mill	1	1	1
Alternative Power	0	0	0
Cultural			
Churches	1	3	4
Community Halls	9	12	14

Asset	Total Number of Assets Impacted by Flooding Scenario		
	MSLER*	HTER**	HTERSS***
Comfort Centers	1	1	1
Recreational Facilities	2	3	3
Museums	0	1	1
Playgrounds	0	1	2
Cemetery	7	11	16
Shooting Range	0	1	1
Schools	0	0	0
Municipal services			
Wastewater Treatment Plant	4	4	4
Lift Stations	7	8	8
Dover Fire Station	1	1	1
Water Treatment Plant	0	0	0
Municipality of the District of Guysborough Offices	0	0	0
RCMP Station	0	0	0
Emergency Health Services	0	0	0
Emergency Operations Center	0	0	0

Reference to sea level and coastal flooding scenario:
*Mean Sea Level and Expected Rise/ Subsidence
**High Tide and Expected Rise/ Subsidence
*** High Tide and Expected Rise/ Subsidence and Storm Surge

It is noted that some available GIS files may be incomplete inventories of the total number of assets in the MODG; therefore, the analysis and subsequent risk assessment is limited by the available data at the time of the analysis.

The impacted properties were assessed at the individual property parcel level. A property was identified as being impacted by the flooding scenarios if any portion of the parcel intersected with each sea level rise scenario, this does not necessarily indicate that buildings or other important assets within the parcel are flooded. Therefore, when assessing the number of properties impacted by the flooding events, portions of the individual property may be impacted but not vulnerable if no assets are exposed.

The GIS files containing the asset information from the municipality and Open Data Nova Scotia consisted of a variety of data files. Layers such as roads, railroads, tracks and trails, transmission lines and pipelines were analyzed. The total number of impacted assets presented in Table 3.5 may include the same asset counted multiple times if the asset as many parts, such as long roads which are divided into multiple sections. For example, Route 316 was subdivided into multiple sections along its length and each of the impacted (flooded) sections were counted individually in the summation of the total impacted assets for the roads. This aids in identifying exact locations along the asset which are impacted by various flooding scenarios.

CHAPTER 4 RISK AND VULNERABILITY ASSESSMENT

Source: https://www.cbc.ca/news/canada/nova-scotia/storm-surge-atlantic-coastline-1.4561552

The purpose of a vulnerability assessment is to identify municipal assets and infrastructure that is already (from a past weather event) or may become vulnerable to climate change and extreme weather events. The assessment scope includes determining the highest ranked vulnerabilities through a risk prioritization process (consequence/severity rating x probability/likelihood rating).

The province has allowed municipalities to determine the scope of their Climate Change Mitigation Plans based on need and capacity. A community can choose to focus on one or two climate impacts that are considered to be the most important at the time of the assessment to address adaptation actions, or alternatively, a community may address all potential impacts at once. In consultation with the Municipality, it was determined that the Climate Change Mitigation Plan for the MODG will focus on the impacts of coastal flooding. Economic and social implications of the extreme flood scenarios were considered in the risk assessment process.

4.1 Risk Workshop

A workshop was help on December 3rd, 2019 in order to engage business and community stakeholders, residents, Municipal Council, Municipal personnel and other key agencies and individuals in the development of the Mitigation Plan. This provided an opportunity for representatives to gain insight and comment on the plan. Furthermore, the workshop provided an opportunity for attendees to provide insight into known flooding vulnerabilities within the MODG. Finally, through consultation, priority municipal assets were identified for severity ranking within the risk assessment.

4.2 Risk Assessment

The risk analysis process is a function of likelihood or probability and consequence of a climate related hazard. The probability of a climatic event occurring in the future, such as flooding, has been developed using future climate projections. The overall vulnerability of the asset was considered when assigning a severity metric.

An infrastructure risk assessment for climate change and extreme weather should answer three main questions: **What can happen? (Scope)**, **How likely is it to happen? (Likelihood)**, and **Given that it has happened, what are the consequences? (Severity).**

There are many risk and vulnerability assessment tools and templates available, such as: community-, engineering-, land-use-, or emergency management-based. The strengths of each of these methodologies depend on the type of infrastructure being assessed. The Public Infrastructure Engineering Vulnerability Committee (PIEVC) is a protocol developed by Engineers Canada for assessing climate risk. The PIEVC protocol is a process for determining the potential effects of climate parameters and extreme weather on infrastructure components. The climate impact assessment presented in this chapter implements a modified risk assessment approach tailored to this flood mitigation plan.

The flooding scenarios depict increasing degrees of sea level rise which include combinations of subsidence, sea level rise, high tide, and storm surge. As the coastal water level increases (increasing severity impacts), the likelihood of occurrence decreases. Severity and probability scores are assigned from 1-3 based on site specific analysis and professional judgment of the assessment team (see Table 4.1). The impacts of extreme water levels were also discussed in the risk assessment workshop. Section 4.1 outlines the probability and severity scores used for this assessment with their qualitative definitions.

Table 4.1 Risk Assessment Matrix Ratings

Likelihood (Probability)	Severity	Score
Low	Low	1
Moderate	Moderate	2
High	High	3

In the context of the flood risk assessment, an asset is vulnerable if it is at or below the assessed flood line elevation and the asset is not designed to be submerged or withstand flooding conditions.

Vulnerability is computed as the product of likelihood (1-3) and severity (1-3) for each asset identified in the risk assessment matrix. Table 4.2 highlights the risk matrix format and the colors outlined in the risk assessment matrix are explained in Table 4.3.

Table 4.2 Risk Assessment Matrix

		LIKELIHOOD		
SEVERITY		1	2	3
	1	**1**	**2**	**3**
	2	**2**	**4**	**6**
	3	**3**	**6**	**9**

Table 4.3 Risk Assessment Color Coding

Risk	Color	Description
High Risk		Highest priority, mitigation required.
Moderate Risk		Mitigation optional.
Low Risk		Low priority, removed from assessment.

The risk assessment considers the impact to people (health and safety, displacement, loss of livelihood, social implications, and reputation), the economy (infrastructure damage, financial impact), and the environment (air, water, land, ecosystems). The completed risk assessment matrix is outlined in Appendix B. When prioritizing adaptation efforts, the following considerations were applied in order of importance within the severity classification:

- Public Safety
- The protection and continued service of essential services such as power, transportation, emergency response, health care services, and sewage treatment and conveyance
- The protection of residential buildings and infrastructure that support the community and local economy

Generally guides to climate change adaptation planning recognise that each municipality has unique needs and capacity to engage in adaptation, and therefore; the adaptation plan designed for the MODG (and the resulting recommended actions) are determined based on available resources and capacities. The resulting five highest ranked impacts for adaptation are summarized below. Multiple impacts have been grouped where the impacts and/or adaptation strategies coincide. The selected highest ranked flood impacts for focus in the mitigation plan include:

- **Local Economy** - Coastal flooding can impact local economy through flooding of wharfs and shipping terminals, washout and erosion resulting in loss of land or roads, and flood damage of critical infrastructure and export lines, including transportation and pipelines. Climate change impacts aquaculture through acidification, increasing sea temperatures, changes in circulation patterns, ecological changes and sea level rise, as well as from the increasing frequency and severity of extreme storm events (Bueno, 2017).

- **Wastewater Collection** - During extreme flooding events, sanitary sewage collection system infrastructure (particularly lift stations and wastewater treatment facilities) may become flooded which can have significant impacts on the electrical and mechanical equipment as well as system performance.
- **Roads required for Access** - Vital access roads may become flooded or washed out during extreme events which isolate community members and impact emergency services and first responders. The fire station provides significant emergency services and first responders to the municipality and is a major public safety concern if these services are weakened by flooding. The Dover Fire Station its self is within a flood line.
- **Electrical Substations and Power Outages** - Extended power outages and infrastructure damage could occur if a substation were flooded during a storm surge event. A power outage would impact wastewater infrastructure such as lift stations (leading to untreated wastewater overflows), emergency services centers (including warming shelters), and local residents.
- **Buildings** - Residential homes vulnerable to flooding can incur significant damage and economic loss, and is a concern for public safety.

CHAPTER 5 FLOOD MITIGATION AND ADAPTATION PLAN

This Chapter outlines a series of adaptation actions for the top priority vulnerable assets determined though the risk assessment process documented in Chapter 4. The purpose of each recommended action is to improve community resilience to climate change and flooding impacts. Adaptation actions presented in this chapter vary in size and complexity. Flood risk has been linked to storm surge impacts across the Province and it is therefore recommended that adaptation planning to address potential impacts of coastal flooding considers both SLR projections and storm surge flooding risks.

When developing adaptation plans to combat the effects of a sea level rise and coastal flooding, there are five strategies typically used: Avoid, Retreat, Accommodate, Protect, or Proceed (Leys, 2016). Determining the preferred strategy greatly depends on the infrastructure in question, the associated level of risk, as well as the cost-benefit of implementing said plan. These five flood mitigation options are outlined and discussed in greater detail below:

- **Prevent/ Avoid the Risk** – Prevent building infrastructure in flood plains. Most directly affected by zoning is the avoidance of development within flood-prone areas or below applicable flood elevations. This may be refined as restricting all new development within the floodway, and restricting development in flood fringe to non-essential uses. Sports fields and parks are one potential use of land in flood risk areas that results in minimal consequence of flooding. Prescribing flood proofing measures. Example: Set-back limits for new development (refer to the Nova Scotia Coastal Protection Act).

- **Retreat** – Move existing infrastructure or assets to higher ground outside of the flood plain. Where possible, this measure entails moving buildings and essential infrastructure and services out of the floodplain. Example: relocate buildings outside of flood plain.
- **Accommodate/ Adapt Existing Infrastructure** – Modify construction to flood resilience builds. Where the risk of flooding is understood and accepted, the risk may be accommodating by adapting to its impacts. Development within the floodplain can be adapted to by locating essential systems and infrastructure off the ground floor, or by prescribing a minimum elevation, for example establishing a minimum freeboard above the 100-year flood line elevation. Example: Raise building on pilings above flood level.
- **Protect Existing Development** – Construct engineering solutions to prevent flooding. Exemplified by the City of Toronto, the more resource intensive measure to reduce the flood risk is protecting the flood-prone area from flooding. This may involve either the reduction of flood severity, or the physical management of flood water via the erection of flood protection structures like berms, walls or barriers, or the modification of the landscape with extensive landforms. Example: Construction of dykes and sea walls to protect buildings.
- **Proceed** – Accept inherent risks and potential infrastructure loss. Example: the adaptation measures are more costly than the asset itself.

There are characteristic advantages and disadvantages to each approach, summarized in Table 5.1.

Table 5.1 Approaches for Adapting to Sea-Level-Rise and Coastal Flooding

Approach	Benefit	Drawback	Cost
Prevent	Lowest exposure to flooding	Doesn't deal with existing infrastructure	Low
Retreat	Low exposure to flooding	Required public by-in and available space to relocate buildings	High
Accommodate	Doesn't require new land purchase	Maintains some exposure to flooding	Moderate
Protect	Doesn't require new land purchase or any modification to existing buildings.	Engineering methods are expensive to construct and require on-going maintenance. The water frontage is not as enjoyable.	Extreme

In terms of planning and building services, other Canadian jurisdictions have used floodplain definitions and flood level forecasts to develop adaptation policies and regulations framing development in the floodplain. Examples are summarized in Table 5.2.

Table 5.2 Jurisdictions with Policies for Development in Floodplain

Jurisdiction	Planning Based Floodplain Management
Dieppe	The City of Dieppe has also produced a Climate Change Adaptation Plan which recommends several policy initiatives to control and manage flood risk. In response, the zoning by-law prescribes a (in section 3.19) minimum geodetic elevation for all new development, and the requirement that non-conforming development applications are to exempt the City of any liability. Development of habitable space or occupied floor space must have a minimum geodetic elevation of any floor of at least 10.5m, representing the projected flooding level for a storm with a 1:100 return period in 2100. Development of a residential care facility, daycare centre, educational use, a health services use, a hotel, a safety and emergency services may be permitted with floors at a minimum geodetic elevation of 9.25m, representing the projected flood levels for a storm with a 1:100 return period in 2014, if they have a site drainage plan demonstrating the elevation of the occupied floor space and a signed copy of the Climate Change Flood Risk disclaimer. It is worth noting that a 9.25m water level is anticipated annually in 2100 due to global warming and the sea level rise. Lastly, a parking garage may be permitted to have an occupied floor space below the geodetic elevation of 9.25 m, as long as the critical elevation (the lowest point on a foundation wall where surface water would first enter) is at least 9.25m and an engineering solution is provided.
Moncton	The City of Moncton has in place a Climate Change Adaptation and Flood Management Strategy that sets out several planning policies for ongoing monitoring and identification of flood risk, and puts in place a flood management strategy with several adaptation measures, including: • Completion of a major storm/hurricane/flood emergency response plan • Community engagement plan • Urban forest management plan • Heritage and civic property assessment in flood prone areas • Storm water and flood plain management strategy and plan • Reduce storm water run-off volumes • Minimum floor elevations for habitable space and structured parking associated with new development • Landscaping provisions to assist in containing storm-water run-off • Increased development setbacks from watercourses to 30m The strategy’s recommendations are not incorporated into the zoning by-law, which at a minimum restrict (in section 1.3 11) buildings or structures on a site where it would otherwise be permitted under the by-law, when in the opinion of the Committee, the site is marshy or subject to flooding.
Shediac	Shediac has incorporated policies in its Municipal Plan requiring that development in flood-prone areas be adapted to mitigate the effects of sea level rise. Consequently, the city’s zoning by-law stipulates (in section 17.4) that, for new buildings, main buildings placed, erected or altered in an SLR zone shall have a minimum elevation for the habitable portion of the building and/or for a commercial building or 4.3 m, based on CGDV28. In the case of existing buildings in the SLR zone, extensions may only be permitted if they do not reduce the existing building elevation.

Truro	The Town of Truro Municipal Planning Strategy delineated the 1:20 and 1:100 flood risk elevations for the Salmon River as early as 1988. It defines a Flood Plain Zone below the 1:20 flood elevation, further demarcated between a Floodway Overlay and a Flood Fringe Overlay, and set outs several development control policies, governing the type of development allowed in each zone. The Town's zoning by-law clarifies both the land uses and development rights within each Flood Plain Overlay. Furthermore, the zoning by-law identifies specific Hydrologic Regions, according to their water retention capacities, and provides detailed flood proofing standards for each Overlay.
Toronto	The City of Toronto has established a number of Special Policy Areas (SPA) designed to address flood risks in flood-prone areas, primarily at the mouth of the Don River. While steps have been taken to protect existing development by improving the conveyance of the Don River mouth and by constructing landforms, areas in the south-east of the city remain flood-prone. Development controls are in place limiting new development in this SPA unless flood adaptation is included in the development plan and the City is absolved of responsibility in the event of a flood event. Ongoing work is underway to identify additional flood risk reduction measures ranging from improved watercourse conveyance, to flood protection structures and landforms. The Don River regulatory flood plain is based on the more severe of the Regional Storm (Hurricane Hazel) level, or the 100 year storm.

5.1 Floodline and Flood Elevation Application

As described in Section 3.2, the flood lines used to complete the Flood Mapping and the Vulnerability and Risk Assessment were the best available at the time of the assessment at the project location. The flood lines were developed by WSP (previously Genivar Inc.) in 2013 and presented to council within the Municipal Climate Change Adaptation Plan (Genivar Inc and Guysborough Climate Change Adaptation Committee, 2013).

At the time of the Risk and Vulnerability Assessment following the Flooding Analysis, the 1:10,000 Provincial topographic mapping was the best available elevation data, which was used to generate the WSP 2013 floodlines within the MCCAP report (Genivar Inc and Guysborough Climate Change Adaptation Committee, 2013). However, since completion of the Risk and Vulnerability Assessment, the Province of Nova Scotia has flown updated high-resolution LiDAR data of the entire province which will be released sometime in 2020. Applying the coastal flood elevations derived within the 2013 MCCAP to the high resolution LiDAR may result in changes to coastal inundation areas across the Municipality. This in turn may impact the areas or the number of municipal assets identified as vulnerable to flooding within the Flooding Analysis and the Risk and Vulnerability Assessment. Furthermore, the coastal water levels derived within the 2913 MCCAP are outdated and coastal flood elevation should be determined with the current best available coastal water levels such as; current sea level rise projections, tidal elevations, storm surge, and return period data. Application of the mitigation options presented below should be applied to the most recent or best available coastal water elevations and floodlines.

The following sections outline the flood mitigation and adaptation options identified for the MODG.

5.2 Local Economy

Due to the nature of the local landscape, the main economic activities and large proposed infrastructure projects in the MODG are typically located along the coast making these activities inherently vulnerable to sea level rise and coastal flooding. Identification of vulnerable areas through flood mapping and risk assessment provides the municipality, proponents and stakeholders with the advantage of proactive planning for sustainable development and flood-resilient design of proposed infrastructure projects along the coastline. A lack of available flood plain mapping in another jurisdiction does not imply that no flood risk exists. In fact, a lack of available mapping could imply added risk for a developer who doesn't have the information required to make an informed decision about flood risk.

It is recommended that site specific surveys be completed at the proposed project locations for new developments identified below (or others) in order to determine the appropriate elevation for planning of critical infrastructure. A site survey may also identify locations in which adaptive measures for protection of existing critical infrastructure is required, as well as determine the feasibility of the available adaptive and mitigation options. Per Section 5.1, it is recommended that updated coastal water and flood elevations and flood mapping be referred to in the final decision and application of the presented mitigation options.

5.2.1 Existing Infrastructure

The Martin Marietta Quarry at Aulds Cove has existing infrastructure located in the Strait of Canso adjacent to the Canso Causeway. The Quarry mines and produces aggregates for export, which relies on the Nova Scotia Highway 104, railroad lines and shipping terminal.

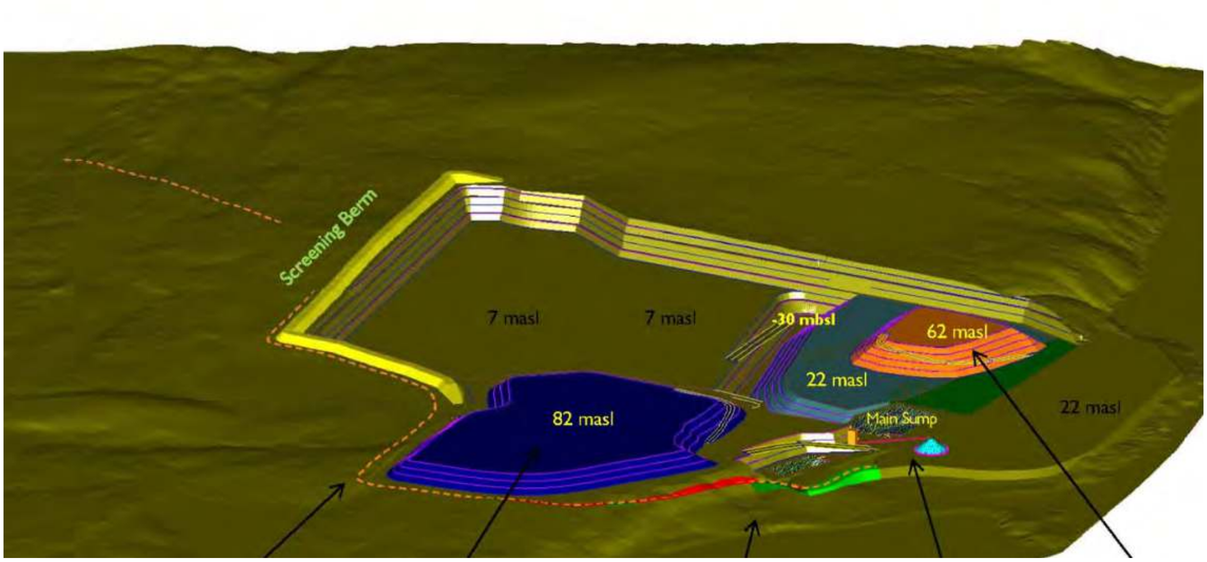
A site survey will allow for elevations of critical existing infrastructure and grade to be identified in order to support a comprehensive, site-specific impact assessment. Once flood vulnerabilities are identified, site-specific adaptation and mitigation options can be reviewed for feasible flood protection actions.

A potential course of action for flood mitigation at the Quarry is to use the existing aggregate material onsite to regrade the site above flood elevation. Furthermore, imagery from Google Earth shows an existing seawall composed of rock at the site. Once elevations of the seawall are determined, the seawall may be built up to projected flood elevations to enhance protection. Additional pumping requirements to remove water from the site and keep critical infrastructure dry may need to be considered. Furthermore, elevating critical equipment or buildings above flood elevation may also be a feasible flood mitigation action.

5.2.2 Proposed Industrial Development

Proposed developments such as The Vulcan Materials Tidal Quarry, Pieidae (Goldboro) Energy LNG Terminal, and Melford Atlantic Gateway Terminal provide an opportunity to construct flood resilient infrastructure and consider climate change in design specifications.

(Rendering of the proposed Goldboro LNG project Photo By Pieridae Energy)



(Black Point Quarry Project, Environmental Impact Statement)

(Melford Atlantic Gateway Terminal, Melford Atlantic Gateway)

As a best practice, it is recommended that new development is built with climate change flood mitigation in mind. A site survey should be completed at proposed project locations to determine site elevations and compare the feasibility of mitigation options available. Building new sites and infrastructure outside of the flood plain or above flooding elevations will reduce the risk of flooding, loss or damage to assets and protect investments. Grading of the site above applicable flood elevations or locating buildings outside of the floodplain are typical flood mitigation options adopted in new construction.

5.2.3 Tourism and Campgrounds

Due to the nature of local tourism, which typically involve outdoor activities that are exposed to the environment, the priority mitigation option is to provide valuable flood risk and safety information and ensure the well-being of tourists. Specific camping sites that are periodically prone to flooding may be relocated to ensure the safety and protection of campers. Warnings may be issued to park and camp residences or parks may be closed before large projected storm events.

Changes in precipitation, sea level, and storm events are known to accelerate coastal erosion and shoreline retreat, this results in a changing morphology of the beach landscape and accelerated loss or deposition of sediment (ex. sand) depending on local processes (Enríquez, Marcos, Álvarez-Ellacuría, Orfila, & and Gomis, 2017). Furthermore, warmer ocean temperatures may result in increased occurrences of algal blooms and decreased water quality which may impact the attractiveness of beach areas (Lemmen, Warren, James, & and Mercer Clarke, 2016).

5.2.4 Aquaculture

In Canada, aquaculture is a growing and evolving economic sector. The industry produces approximately 190,000 tonnes annually exporting approximately 103,000 tonnes overseas (Canadian Aquaculture Industry Alliance, 2018). Overall the sector generates $5.4 billion in economic activity in Canada. Aquaculture employs 26,000 workers nationally and accounts for 33% of Canada's total seafood value (Canadian Aquaculture Industry Alliance, 2018). Requirements for the fishery and aquaculture sectors to adapt to the direct and indirect impacts of climate change has been stated with high confidence within the IPCC AR5 report (Bueno, 2017). The IPCC AR5 further states that the specific ecosystem and region are of significant importance when determining the relevant effects of climate change.

Climate change results in physical, chemical, and biological changes to the environment which have the potential to cause significant impacts to the aquaculture sector. Fish are directly impacted by their environment and as a result breeding, feeding, and migration patterns may change under a warming and evolving climate. Increasing temperatures and heat waves including an increasing risk of temperature anomalies such as extreme cold or hot snaps impact aquaculture projections and sustainability in Global markets. Climate change is projected to cause shifts to global circulation patterns, ecological changes, sea level rise, and increases in the frequency and severity of extreme storm events. Another major impact of climate change is ocean acidification which is predicted to have major impacts on shellfish productions. Climate change is also projected to affect the productivity and yield of selected species, available habitats and structure of the food web throughout the ocean ecosystem as a whole. Furthermore, national and international industry factors including future costs, water allocation and marketing may also experience significant changes in the future (Shelton, 2014).

Nationally, warming temperatures, variability of water availability and salinization of coastal waters which will impact inland aquaculture farms. Furthermore, inland and coastal fisheries may experience reduced habitat quality and availability of dissolved oxygen and nutrients as a result of algal blooms, eutrophication and stratification of ocean environments. In general, the toxicity of environments is expected to increase in the future due to increased development and emissions. Ocean acidification is predicted to have major impacts on shellfish productions (Shelton, 2014).

Due to the projected increase in the frequency and intensity of storm events, damage to fish farm infrastructure and materials may occur on coasts across Canada. This may disrupt services and production rates as well as impact other activities within the value chain. These conditions are projected to cause stresses and physiological effects which may impact development and increase susceptibility to disease. Heavy snowfall in the Northern provinces caused power outages and as a result aquaculture stocks experienced increased mortality rates due to inoperability of hatcheries and indoor farms. Sea level rise will increase inundation of saline waters which may impact freshwater production systems in areas vulnerable to coastal flooding. In addition, storm surge may alter or submerge coastal habitats and increase coastal erosion rates (Bueno, 2017).

In general, potential advantages of climate change in regards to aquaculture include the generation of new opportunities and environments as a result of sea-level rise. Coastal flooding or inundation of low lying areas coastal areas or land adjacent to deltas may provide new areas for aquaculture opportunities such as brackish water fish and shrimp. Furthermore, potential global or regional shifts in fish population distribution may result in the availability of new fisheries in the future within the region. This change however may also pose issues as the timing of poleward shifts of warmer and colder water species is variable and unable to be predicted at this time. This global redistribution is projected to have significant impacts to local catch potential. Therefore, long-term aquaculture plans within the MODG will need to monitor and adapt to these projected changes in order to be sustainable (Shelton, 2014).

Guysborough harbour is partially sheltered from the large southerly Atlantic storm effects due to the Canso peninsula to the South. Based on historical tide gauge records at nearby Point Tupper, it is estimated that extreme storm surge levels are somewhat less than at more exposed harbours such as Halifax. In addition, the barrier beach at the mouth of Guysborough harbour provides effective protection against ocean wave agitation.

The adaptive capacity of aquaculture farming operations is relative to site specific features. These features include; fragility of the ecosystem, site location (low-lying, exposed, accessibility, inland or coastal), infrastructure design and purpose. Mitigation options are enveloped by three main categories; structural and physical, social and management, institutional (Bueno, 2017). These categories are discussed in more detail below:

- **Structural and Physical**
  - Implementing engineered or environmental protections such as seawalls or coastal protection.
  - Adapting and selecting technologies such as advanced farming techniques or systems, vulnerability mapping, early warning systems.
- **Social and Management**
  - Increasing education of the challenges, mitigation and adaptive opportunities within the aquaculture sector.
  - Developing information assets such as hazard and vulnerability mapping, early warning systems, adaptation planning, and scenario development.

- Providing essential services such as energy backup, emergency services
- Implement behavioral change to include mitigation of climate change impacts through accommodation, retreat, migration, livelihood diversification, changing aquaculture practices.
- Organizational (e.g. aquaculture area management under the Ecosystem approach to Aquaculture (EAA) (FAO and World Bank, 2015)).

Institutional

- Implement economic programs such as financial incentives including taxes and subsidies, payments for ecosystem services, insurance.
- Laws and regulations (e.g. building standards, defining property rights and land tenure, marine-protected areas, farming and fishing quotas, ethical employment, appropriate incentives)
- Government policies and programmes (e.g. mainstreaming climate change into national and regional adaptation/development plans, integrated coastal zone management, fisheries 12 management, community-based adaptation, disaster planning and preparedness

5.3 Wastewater Collection

Wastewater collection infrastructure includes sewage treatment plants, lift stations, and associated buildings. According to the vulnerability assessment, four (4) wastewater treatment facilities (WWTFs) and eight (8) lift stations are vulnerable to flooding within the MODG. Lift stations are located in the Communities of Guysborough and Canso. WWTFs are located in the Communities of Guysborough, Canso, and Little Dover. A number of sewer lines within the Communities of Guysborough and Dover have been identified to be within the floodplain. Although sewers are unlikely to sustain significant damage from inundation, this may lead to flooding in the municipal system. Wastewater collection system assets are further discussed in the sections below along with the presentation of adaptation and mitigation options.

5.3.1 Wastewater Treatment Facilities

Wastewater treatment plants are typically constructed at low elevations, near water bodies, to accommodate gravity sewer systems that reduce pumping requirements and allow for discharge of treated water to the environment. For this reason, WWTFs are generally vulnerable to flooding. A total of four (4) wastewater treatment plants have been identified to be vulnerable to coastal flooding within the MODG. These WWTFs are located in the Communities of Guysborough, Canso, and Little Dover as presented in Table 5.3, and illustrated on Figure 5-1 to Figure 5-6.

Table 5.3 Vulnerable Wastewater Treatment Plants

Asset	Location		Impacted by Coastal Flood Scenario?		
	Location	Coordinates	MSLER	HTER	HTERSS
Rotating Biological Contactor	Main Street, Community of Guysborough	45°23'30.19"N, 61°29'50.72"W	Yes	Yes	Yes
Lagoon	Marine Drive, Community od Guysborough	45°24'13.73"N, 61°30'27.53"W	No	No	Yes
Activated Sludge Plant	Union Street, Community of Canso	45°20'3.39"N, 60°59'5.28"W	Yes	Yes	Yes
Recirculating Sand Filter	Dover Road, Community of Little Dover	45°16'48.51"N, 61° 2'10.73"W	Yes	Yes	Yes

Many impacts may occur if a WWTF becomes flooded. These impacts can include service disruptions or complete loss of wastewater treatment services, raw sewage leakage, washout, and foul odour. Additional pumping and associated costs to keep critical infrastructure components dry may be required during flood events, if possible. This may require diesel generators during a power outage.
WWTFs have significant subsurface infrastructure such as pipes, electrical components, tanks, and liners. Reduction to the life span of individual infrastructure components may occur if frequently inundated or exposed to brackish water. Critical infrastructure located outdoors, such as the sand filters

at the Dover facility and the aeration tanks at the Canso facility, would be directly exposed during a flooding event. Critical mechanical and electrical/ instrumentation equipment located within control buildings are also vulnerable if situated below flood elevations.

The following mitigation and adaptation options presented below are identified to mitigate flooding impacts at wastewater treatment facilities. It is recommended that a site survey be completed on the vulnerable facilities in order to identify elevations of critical and flood protection infrastructure. This will impact the application of the adaptation and mitigation options presented.

- **Option 1: Pumping -** WWTFs such as lagoons and recirculating sand filters are designed with freeboard which can work to accommodate increased water elevations during flooding events. Additional pumping efforts to keep critical infrastructure components dry as well as to maintain water levels in the plant is possible during flood events with sufficient equipment. Pumping out the facility may be required if water elevations exceed the floor elevation. There are costs association with pumping, but costs are likely low compared to the cost of replacing water damaged building materials and equipment. The cost of pumping can vary greatly depending on the required size and usage.
- **Option 2: Flood Protection Infrastructure -** Protective measures such as the construction of dykes or seawalls to accommodate flood elevations act to protect WWTF from flooding during large storm events or sea level rise. Erosion protection, such as riprap or stabilizing features such as core material with low permeability could be considered if flood protection infrastructure is located along the coast and subject to wave action, tides, and or frequently experiencing elevated water levels. The construction of dykes or seawalls, as proposed above, may exasperate flooding if surface water drainage is properly managed and raising of the water table through infiltration. Therefore, this adaptation strategy may require pumping or other modes of water conveyance such as aboiteau structures.
- **Option 3: Raising Critical Infrastructure –** Raise critical electrical or mechanical systems to protect against flooding damages, these systems may include; panels, blowers and motors. The cost of elevating these systems are estimated to range from $50,000-$80,000.
- **Option 4: Relocating the Wastewater Treatment Plant -** In the long term, relocation is likely to provide the greatest reduction of coastal flood risks. It is noted that identifying and permitting a new location for a WWTP may be difficult. Due to the long-term increases of sea level rise, protective measures may be feasible within the short term. However, relocation can be the lowest risk option. The cost of building a new wastewater treatment plant was estimated to be approximately $4,000,000.

Figure 5-1 Affected Waste Water Treatment Facilities – Guysborough (GIS Map)

Figure 5-2 displays the Rotating Biological Contractor WWTP and the surrounding building located off of Main Street in Guysborough. It is recommended that a survey be completed at the WWTP in order to determine critical elevations of vulnerable infrastructure and ground/floor elevations. The surrounding building does not provide protection from coastal flooding vulnerabilities. Mitigation options to protect the WWTP against flooding damages include raising mechanical, electrical or important equipment above the highest flood elevation, or raising the entire building above the highest flood elevation. It is noted that the plant is gravity fed which must be considered when evaluating changing elevations of critical infrastructure. Alternatively, upon a site evaluation, moving the structure to a more feasible location or outside of the flood zone may be considered the best mitigation option. Through preliminary evaluation of the site, including assessment of aerial photography and a site visit on March 5th 2020, it was determined that the construction of berms around the plant is not feasible due to lack of available area surrounding the site.

Figure 5-2 Main Street Rotating Biological Contactor - Guysborough

Figure 5-3 displays the Wastewater Treatment Lagoon located on Marine Drive in Guysborough. According to the flood mapping, the North East corner of the Lagoon is vulnerable to flooding impacts at the highest flood line elevation. Therefore, building up the North East corner of the berm to applicable flood elevations may protect the Lagoon from flooding vulnerabilities. A small shed located to the North East of the Lagoons was identified as a possible utilities shed associated with the Lagoon Plant facility. The building is within the flood zone and should be considered when evaluating flooding vulnerabilities of the plant. Mitigation options include raising mechanical, electrical and important equipment above flood elevations or raising the building above flood elevations. Furthermore, relocation of the building outside of the flood zone would protect the asset from flood vulnerabilities.

Figure 5-3: Wastewater Treatment Lagoon - Guysborough

CBCL completed an evaluation of the Canso sewer utility in 2011 as well as a WWTP and Collection Improvements and Repairs study in 2010. The WWTF servicing Canso is an Activated Sludge Plant (see Figure 5-5). The collection system within the community consists of approximately 10,730 m (35,200 ft) of gravity collection pipe, five sewage lift stations, 1.6 km of forcemain, and 174 manholes (1050 mm diameter). The WWTF has a design capacity of 379,000 Lpd (83,500 Igpd) and was processing an average of 1,163,520 Lpd (256,000 Igpd) of sewage, with peak wet weather flows of 2,661,000 Lpd (585,500 Igpd) at the time of the reporting. The 2011 report notes that the majority of the wastewater collection system is over 40 years old, which is older than the average useful life of a collection system (approximately 33 years) as reported by Statistic Canada. The 2010 report concludes excessive inflow and infiltration (I&I) is occurring in the collection system through manholes, service connections, and pipe joints. Flood risk in the sewer system may increase as sea levels rise and the intensity and volume of precipitation increases with climate change. It is typical for rainfall and high winds to coincide with storm surge events.

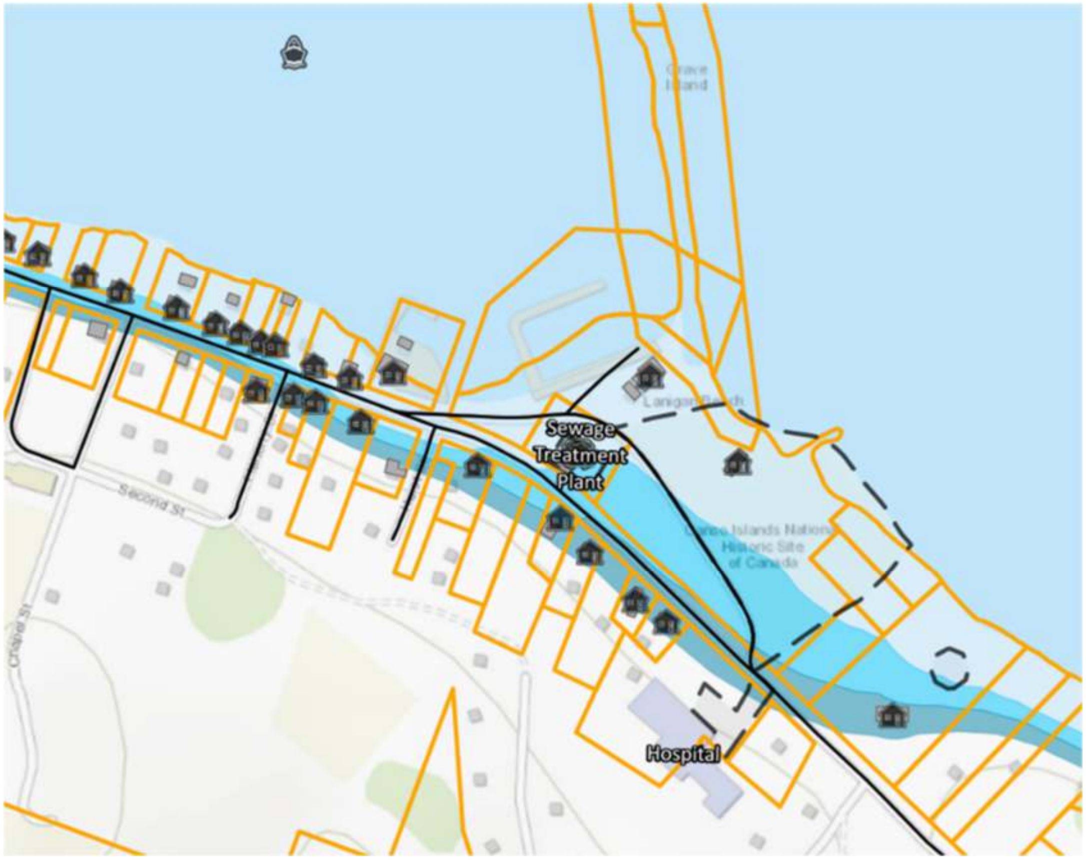


Figure 5-4 Affected Waste Water Treatment Facilities – Canso (GIS Map)

Figure 5-5 Union Street Activated Sludge Plant - Canso

Upon evaluation of aerial photography it was determined that the WWTP in Canso may have the required available area to construct flood protection berms around the site to accommodate flood elevations and protect against vulnerabilities.

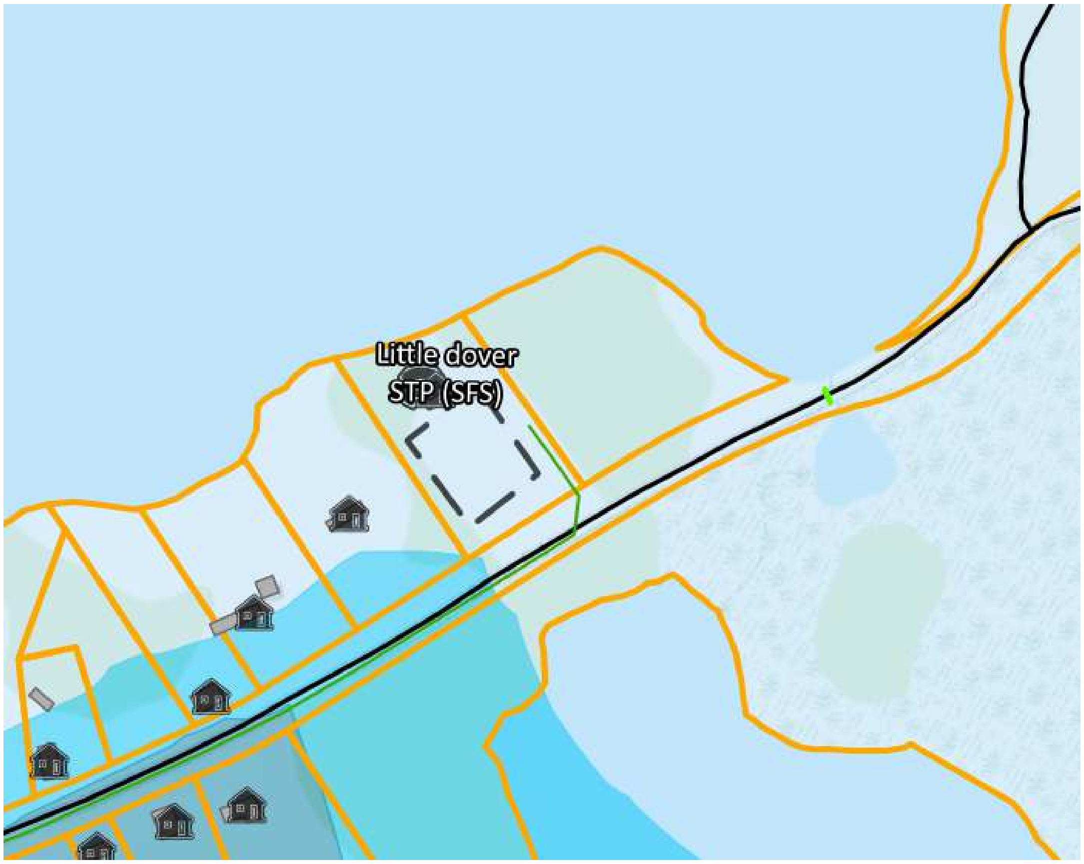


Figure 5-6 Affected Waste Water Treatment Facilities – Little Dover

5.3.2 Sewage Lift Stations

Sewage lift stations (SLSs) are used for pumping wastewater from lower to higher elevations. Of the ten (10) lift stations within the MODG, eight (8) were identified as directly vulnerable to coastal flooding. These lift stations are located in the Communities of Guysborough and Canso, and the general coordinates and degree of vulnerability are outlined in Table 5.4 below, and illustrated on Figure 5-7 and Figure 5-8.

Table 5.4 Vulnerable Sewage Lift Stations

Identifier	Asset	Location		Impacted by Coastal Flood Scenario?		
		Community	Coordinates	MSLER	HTER	HTERSS
1	Marine Drive	Guysborough	45°23'46.55"N, 61°30'11.71"W	Yes	Yes	Yes
2	Marine Drive near North Street	Guysborough	45°23'39.82"N, 61°30'1.80"W	No	Yes	Yes
3	Main Street Near Russell Lane	Guysborough	45°23'21.66"N, 61°29'46.68"W	Yes	Yes	Yes
4	Church Street Extension	Guysborough	45°23'16.41"N, 61°29'51.50"W	Yes	Yes	Yes
5	Lower Water Street	Guysborough	45°23'1.21"N, 61°29'33.14"W	Yes	Yes	Yes
6	End of Water Street	Canso	45°20'24.05"N, 61° 0'21.37"W	Yes	Yes	Yes
7	Water Street	Canso	45°20'14.39"N, 60°59'42.12"W	Yes	Yes	Yes
8	Union Street	Canso	45°20'8.88"N, 60°59'27.13"W	Yes	Yes	Yes

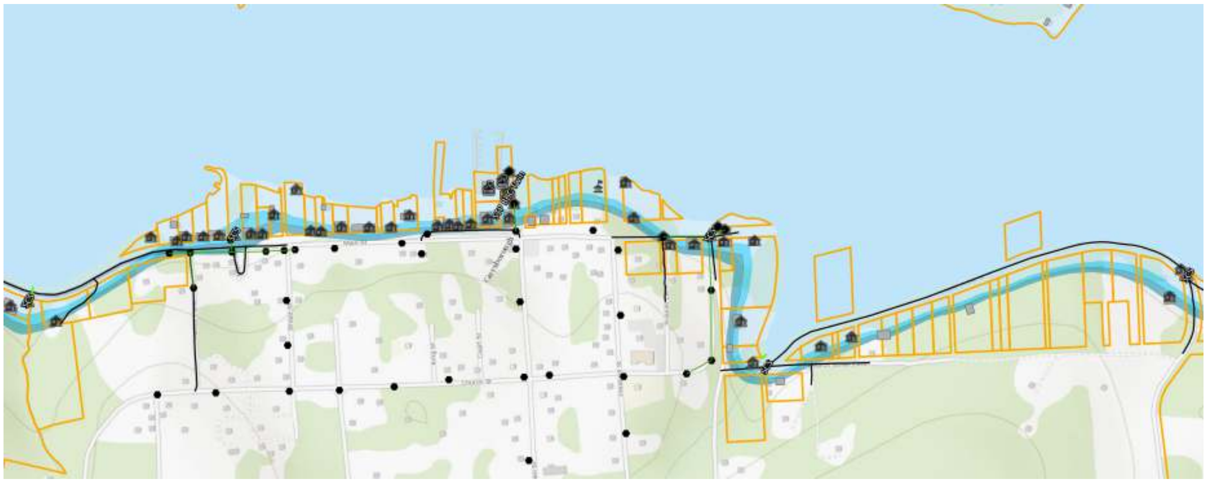


Figure 5-7 Affected Sewage Lift Stations - Guysborough

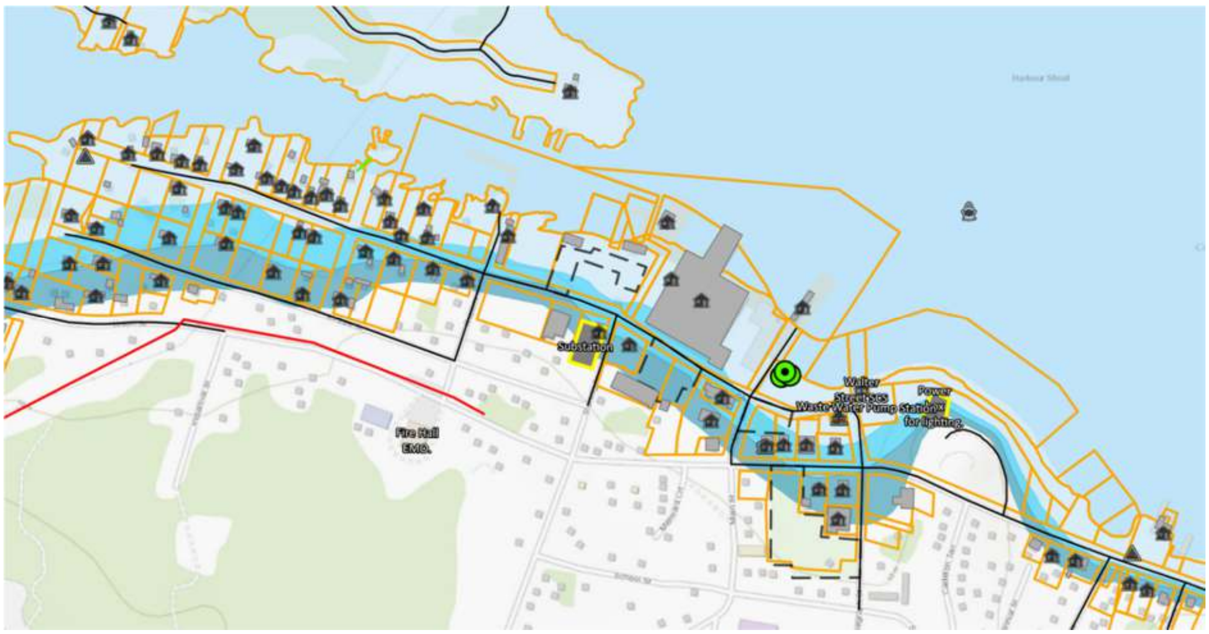


Figure 5-8 Affected Sewage Lift Stations - Canso

It is recommended that the existing conditions of each of these substations be investigated. This will allow for vertical elevations of building, electrical/instrumentation and mechanical components to be determined. This information will help determine the preferred mitigation action of the options described below. Three conceptual design options, described below, were considered for short term and long-term solutions to protect the lift stations from flooding:

- **Option 1: Raising the Building and Components In-Place -**The practicality of raising the station floor elevation and building components in-place above applicable flood elevations will need to be assessed on a site by site basis based on current building and equipment elevations at the vulnerable lift stations. The option to raise the station floor elevation and building components in-place above applicable flood elevations may be an option for some SLSs. Depending on the system connectivity, a temporary bypass pumping arrangement may be required. Upstream manholes may have to be modified to allow a temporary pump to be installed complete with level control equipment. A temporary panel would be required to operate the bypass pump system and a connection would be required from the temporary pump discharge to the existing force main. Once the bypass pumping station was operational, work could be undertaken to raise the building and wet well cover. Once the existing station is raised above the flood line, the site would then have to be built-up to match the new building and wet well cover (or an alternative arrangement with stairs). Considerations for this option would also include driveway access and property limits, as some stations may be constructed on parcels with limited room.

- **Option 2: Raising Critical Station Infrastructure Only** – In this option, only the critical infrastructure is raised lift station above flood elevations. In this option, the existing station would remain in-place. The wet well cover would be elevated above the flood elevation and the electrical equipment could be moved outside the building onto a separate enclosure. The electrical equipment would remain on the station site at a higher elevation in a weather-proof enclosure. The site, or a portion thereof, would be re-graded as required to access the enclosure above the future flood elevation. Figure 5-9 shows an example of what the weather-proof enclosure could resemble. The existing SLS buildings would remain in-place to house equipment that would not be negatively impacted by flooding (i.e. control valves and fittings). The existing control panels and related equipment would remain in-place during construction of the new panels to allow the station to operate without bypass (overflow). New junction boxes installed above the high-water elevation would allow the existing pumps to be reused. The cost of such retrofit may range between $50,000 and $80,000.

Figure 5-9 Example of a Weather Proof Enclosure for Exterior SLS Electrical Components

- **Option 3: Relocating the Station on the Existing Site or a New Site to a Higher Elevation** - The final option is a complete rebuild of the station at a higher elevation. In this option, the site would have to be built-up to a higher elevation to ensure that the building and wet well cover sits at an elevation above the flood line. Considerations for this option would also include driveway access and property limits/acquisition. Additional costs would be incurred due to the need to allow the existing station to remain in operation during construction of the new station. This would mean that new pumps, valves and fittings will all have to be constructed, limiting opportunities to realize cost savings by reusing equipment. Depending on the size and complexity of the station, costs may range from $150,000 to $300,000.

The technical feasibility of each option depends on a site-specific evaluation of the three mitigation options presented above for each impacted SLS. The assessment of feasibility includes a number of factors such as land elevation, existing gravity sewer elevation, building and space constraints, and accessibility. Additional requirements may need to be explored for each mitigation option to tailor to site specific needs.

Upon the site visit on March 5th 2020, a number of the identified vulnerable SLS sites were visited to preliminarily assess the condition of the asset and site-specific feasibility of the presented mitigation options. The SLS publically accessible are presented in Figure 5-10 - Figure 5-13 below. Figure 5-14 presents an aerial photograph from Google Earth of the vulnerable SLS on Lower Water St, Guysborough.

It is noted that the electrical panels associated with SLS's 2 and 3 (Figure 5-11 and Figure 5-12) are attached to nearby utility poles. This is not a common nor recommended installation practice. Freezing rain, high intensity precipitation, storm and wind events are projected to increase in the region over the 21st century as a result of climate change. Therefore, the current placement of these electrical panels increases their vulnerability and exposure to these weather events. Furthermore, any damage which may occur to the utility poll during storm or wind events may impact the asset. It is recommended that electrical panels be constructed on concrete pads above flooding elevations with a protective cover to protect the electrical panel from weather events.

The following are CBCL's preliminary recommendations of flood mitigation options at each of the identified vulnerable SLS sites listed by identifier in Table 5.4 and depicted in Figure 5-10 - Figure 5-17 below:

- **(1) –** Raise the concrete pad of the electrical panel above applicable flood elevations.
- **(2) -** Raise wet well cover and vents above applicable flood elevations. Remove electrical panel from utility pole and station on a concrete pad built above applicable flood elevations with a protective cover to protect the asset from weather events.
- **(3) -** Raise the wet well cover and vents above applicable flood elevations. Remove electrical panel from utility pole and station on a concrete pad built above applicable flood elevations with a protective cover to protect the asset from weather events.
- **(4) –** Raise the concrete pad of the electrical panel above applicable flood elevations and construct a protective cover to protect the asset from weather events. It is noted that the wet well was not identified during the site visit and will need to be assessed during selection of the site specific flood mitigation option.
- **(5) –** The site was unable to be assessed at the time of the site visit. Upon review of aerial photography, it is generally recommended to raise wet well cover and vents above flood elevations. Raise the concrete pad of the electrical panel above applicable flood elevations and construct a protective cover to protect the asset from weather events.
- **(6) -** Raise the wet well cover and vents above applicable flood elevations. Raise the concrete pad of the electrical panel above applicable flood elevations and construct a protective cover to protect the asset from weather events.

- **(7)–** Preliminary flood mitigation options for consideration at this site include constructing a flood protection wall around the underground tank and control building above applicable flood elevations. Or raising the wet well cover and vents above flood elevations and raising electrical, mechanical, or important assets above flood elevations or raising the entire building above applicable flood elevation.
- **(8) -** Raise the wet well cover and vents above applicable flood elevations. Raise the concrete pad of the electrical panel above flood elevations and construct a protective cover to protect the asset from weather events.

Figure 5-10: (1) Marine Drive Sewage Lift Station - Guysborough

Figure 5-11: (2) Marine Drive near North Street Sewage Lift Station – Guysborough

Figure 5-12: (3) Main Street near Russell Lane Sewage Lift Station – Guysborough

Figure 5-13: (4) Church Street Extension Sewage Lift Station – Guysborough

Figure 5-14: (5) Lower Water Street Sewage Lift Station – Guysborough

Figure 5-15: (6) End of Water Street Sewage Lift Station – Canso

Figure 5-16 (7) Water Street Sewer Lift Station - Canso

Figure 5-17: (8) Union Street Sewage Lift Station - Canso

It is recommended that the wastewater treatment network as a whole be considered in addition to flooding consideration of the wastewater treatment plant and SLSs. During flooding events, a number of the manhole structures are flooded. Of the 32 identified points in the manholes layer in the Community of Guysborough, 10 are vulnerable to direct flooding. The Impacted sewer lines can be seen in the flood maps provided in Appendix A. During the flooding events, portions of Main Street and Lower Water Street may become flooded in the Community of Guysborough. Dover Road, in the Community of Dover may become flooded during the storm events as well as a result of sea level rise. Additionally, Dover Lane, Fishermans Lane and Portions of Hillside Drive, as well as a number of peripheral streets off of Dover Road may become flooded as seen on the Flood Maps in Appendix A. Raising the manholes and gravity sewer lines must be considered holistically with the raising of SLSs, roads, and outfalls.

5.4 Access Roads

Road flooding and washouts are expected to occur at multiple coastal locations throughout MODG, under all flood scenarios. The high-level investigation of flooding at the 2100 horizon, the highest coastal flooding elevation (Scenario 3) suggests most significantly, that Highway 16 is highly vulnerable to flooding from at a number of locations along the coast:

- Boylson to Cutlers Cove (approximately 5km)
- Cooks Cove
- Hortons Cove
- Dorts Cove
- Halfway Cove
- Queensport
- Half Island Cove

Additionally, important roads are expected to flood under all flood analysis scenarios at several locations in all coastal communities. Figure 5-18 depicts an example of the proximity of coastal water levels to roads within the MODG. Many roads within the Municipality are directly exposed to coastal flooding without any seaward ditches to collect and store water before it reaches the road. Figure 5-19 depicts the proximity of coastal water levels to a road and bridge elevation within the MODG. It is possible that a number of bridges within the MODG do not maintain adequate freeboard elevations or hydraulic capacity as a result of increasing sea levels and precipitation runoff events.

In Canso, Union Street is the only road serving Canso east of Queen Street. In the event of flooding of Union Street, a number of residences and Eastern Memorial Hospital could be rendered inaccessible.

Figure 5-19: Coastal Water Level proximity in reference to road and bridge elevations in the Municipality of the District of Guysborough

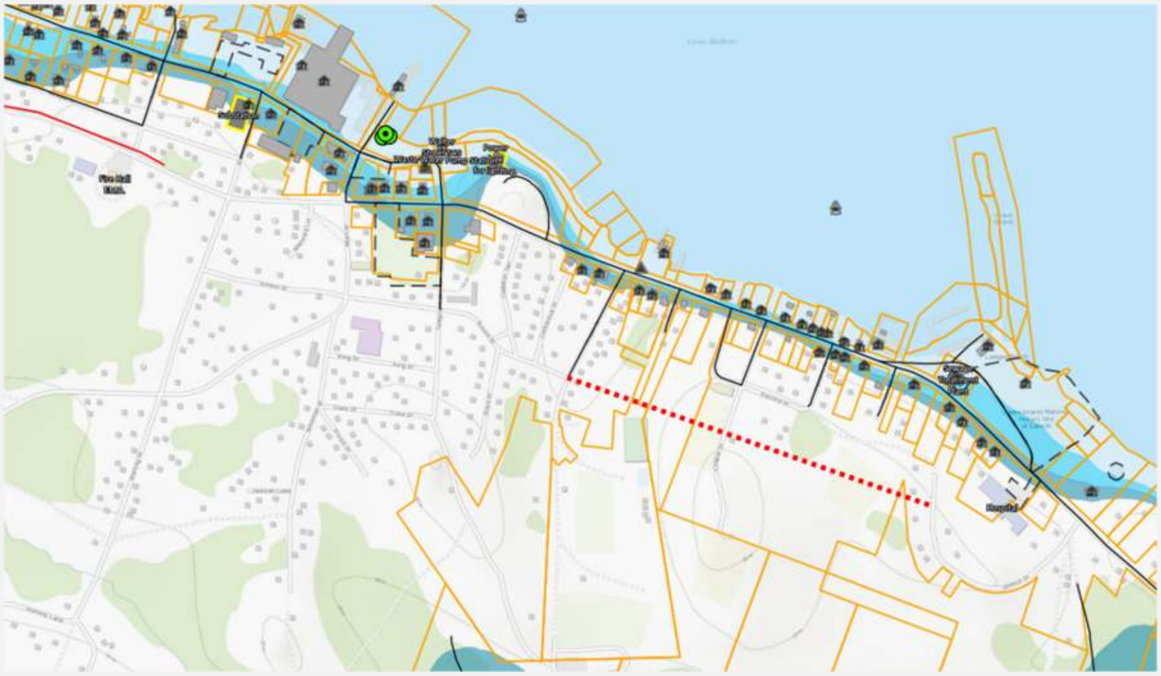
Three options may be considered for the most affected segments of the road network.

- **Option 1: Flood Protection with Dykes, Berms, or sea walls –** Reducing flood risk is possible through the erection of dykes or berms alongside the affected roads. Such protection features must be long enough to completely close off the vulnerable road segment from the sea. Depending on the height of such protection features, costs may run in the order of $2,500 - $4,500 per linear m.

- **Option 2: Raising Vulnerable Road Segments** – In this option, specific road are raised above flood elevations. Keeping acceptable grades may require raising the road for a longer distance than is strictly affected by flood risks. Depending on the new elevation and the width of the affected road segments, costs may run as high as $2 million per km.

- **Option 3: Increasing By-Pass Opportunities –** This option would consider the provision of alternative routes to affected roads to increase community resilience and maintain access to all settled and critical areas. In Guysborough, Highway 16 may have a parallel by-pass via Old Riverside Road from north of Mill Cove to Tomkinsville Road**.** As this affected portion of Highway 16 comes up for recapitalisation, the Municipality should discuss upgrading Old Riverside Road instead. In Canso, an alternative connection to the Hospital may be provided by extending School Road eastward to

Wilmot Street. In the case of Canso, a new 2-lane road though woodland may carry a cost of $1.2 - $2 million per kilometre.



5.5 Electrical Substations

A substation is a vital component in the electrical generation, transmission and distribution grid. If affected by flooding events, these systems can cause electrical service disruptions to large portions of the electrical network resulting in loss of power for customers. Furthermore, due to the nature of the system, exposure to floodwater can cause significant damage and fires which pose a significant safety risk.

A substation has mechanical and electrical equipment which are highly vulnerable to flooding. If substations become flooded, it is highly likely that the damage incurred is irreversible and the entire station may require replacement. A total of four (4) substation were identified to be vulnerable to the flooding events within the MODG. The locations and general coordinates of these vulnerable substations are identified in Table 5.5 below.

Table 5.5 Vulnerable Electrical Substations

Asset	Location		Impacted by Coastal Flood Scenario?		
	Location	Coordinates	MSLER	HTER	HTERSS
Mountain Road at West Cooks Cove Substation	West Cooks Cove	45°20'53.07"N, 61°30'11.70"W	No	Yes	Yes

Mountain Road at West Cooks Cove Substation	West Cooks Cove	45°20'57.60"N, 61°30'10.74"W	Yes	Yes	Yes
White Head Substation	Whitehead	45°14'51.25"N, 61°11'22.55"W	No	No	Yes
Canso Substation	Canso	45°20'17.24"N, 60°59'54.22"W	No	Yes	Yes

Upon further investigation it was determined that if the White Head substation was impacted during a flood event and went offline, a small local population would experience disruptions in power services. The West Cooks Cove substation, owned by Nova Scotia Power (NSPI), is composed of two systems on Mountain Road, and services the Dickie Brook Hydro station. If the West Cooks Cove substation was flooded, no customers will experience service disruptions. A site survey is recommended at each of the vulnerable substations in order to confirm existing equipment elevations. The existing site elevations, as well as site layout, may impact the feasibility and adaptation methods implemented as described below.

The Canso substation is owned by NSPI and services the NSPI-owned Sable Wind Farm. CBCL designed both the Canso substation as well as the Sable Wind project, and as a result, have the elevation for a large portion of the vital substation equipment. Upon review of the substation design drawings, the equipment was designed at elevations of 7.5 m and above. The substation equipment is therefore above the highest projected flood elevation of 5.75 m. Therefore, it was determined that only minor adaptation or mitigation measures would likely be required at this station. This evaluation should be confirmed against the best available coastal flood elevations and floodlines per Section 5.1.

The Canso substation equipment sits on concrete pads and small portions of substation equipment is at grade level. A large percentage of the high voltage equipment is several meters above grade and thus not vulnerable to flooding impacts. Control and LV power cables below grade have been identified to potentially require protection, but this would have to be investigated at the site on a case-by-case basis, as these cables are weatherproof and would need little protection for a short term water level rise.

Figure 5-20 below represents the mitigation and adaptation options for electrical substations described in greater detail on the following page.

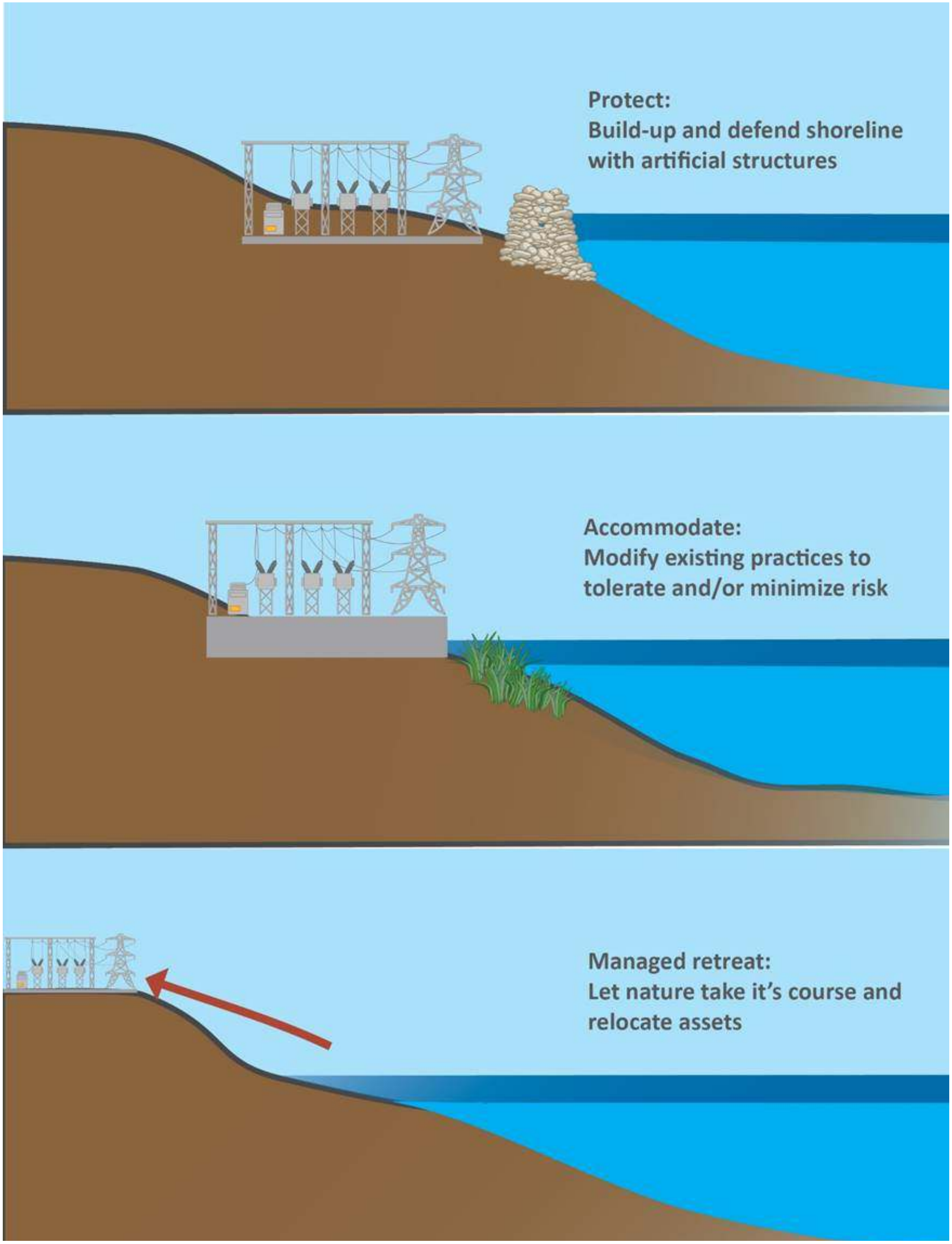


Figure 5-20 Adaptation and Mitigation Options for Electrical Substations

- **Option 1: Flood Protection Infrastructure -** In general, the most cost effective method to protect substations from increased flood levels is to install earthen berms around the substation perimeter. This approach requires consideration of access issues that may be created by the berm, and may require additional measures to protect below grade equipment from water ingress due to hydraulic pressure related flows where water levels above the equipment are expected to be sustained for extended periods. In regards to the Canso substation it was determined that the construction of a clay berm may cost an estimated $75,000 - $100,000. Where berms or localized elevation of the equipment are not practical, "bathtubbing" or creating localized tanks around critical infrastructure is an adaptive mitigation option. This option is most effective for subsurface infrastructure, but consideration must be given to penetrations required for cable entry and exit from the protected equipment. Costs vary widely for this type of installation depending on the size of the protected area and the number and type of penetrations. Cable trenches may be lined and sealed for approximately $100 per meter, whereas dedicated solid surface enclosures around control buildings are estimated to be within the $100,000 - $150,000 range.
- **Option 2: Raising Critical Infrastructure -** At vulnerable locations, if a limited amount of equipment in an area is affected by the higher water levels, consideration should be given to raising the elevations of the affected equipment. Cable trenches can be replaced with elevated cable tray or the cables can be strung aerially. Equipment can also be elevated by the use of structures or thickened concrete pads. The estimated cost for this type of mitigation effort must be addressed on a case by case basis as only the equipment at risk would require adaption. The estimated cost was determined to generally fall within the range of $100,000 - $150,000.
- **Option 3: Relocation of the Substation -** A complete relocation of the vulnerable substation to a higher ground elevation above flood levels is the most costly adaption effort identified and would result in the highest level of flood protection. In terms of the Canso substation, relocation was determined to cost in excess of $7.5 million. It is noted within the *Protecting Assets against an Increasing Risk of Flood Case Study* (Ouranos, 2016) that increasing the height of vulnerable equipment and infrastructure above flood elevations, as well as the relocation of substations outside of the flood zone can generate more cost-benefit advantages than construction of flood-protection infrastructure in the right situation.

5.6 Buildings

The adaptation and mitigation of coastal flooding impacts to residential buildings is of high concern to the Municipality. Mitigation and adaptation options should be assessed on a case by case basis to determine feasibility. The Federal government and Public Safety Canada have experienced increasing requests from provinces for financial aid from homeowners impacted by severe and frequent flood damages. The Disaster Financial Assistance Arrangements (DFAA) program is a financial program to aid provinces during extreme events. Funding is provided in part by the Federal and Provincial government and is subject to the design of the program (Press, 2019).

5.6.1 Prevention and Planning Development

The Canadian Institute of Planners encourages a land-use planning approach to flood vulnerability assessments. Most directly affected by zoning is the avoidance of development within flood-prone areas. This may be refined as restricting all new development within the floodway, and restricting development in flood fringe to non-essential uses. The appropriate water level for planning purposes depends on a number of factors, most prominently: the assets intended life (timeline) as well as the inherent flexibility of the infrastructure to increase the elevation at a later time. The Coastal Protection Act as outlined in Section 2.3 is relevant to building and infrastructure design in coastal areas as defined by the Act and should be referred to in the final decision making process.

As described in Section 4.2, as the severity of the event (water level) increases the probability of occurrence decreases. Therefore, applying the outlined mitigation options based on the lowest to highest flood line results in the most and least undertaken risk to flooding, respectively. It is recommended that assets be evaluated on a site by site (case by case) basis and the acceptable risk to be incurred can be determined. For example, the application of the presented mitigation options may be applied such as:

- Existing vulnerable assets which can handle temporary flooding without damage may be designed to a less extreme coastal flooding elevation;
- Existing vulnerable assets which are nearing the useful expected design life or which can be built upon at a later time may be built to a mid-range flood elevation;
    - Example: this may include mechanical equipment (30 year design life) or roads.
- Significant infrastructure investments may be built to a high or extreme flood elevation to ensure protection and incur the least risk.
    - Applicable for flood mitigation measures.

It should be noted that there are local and regional socio-economic considerations that should be accounted for when making recommendations that are cognizant of those aspects. It is further emphasized, that the coastal flood elevations used to apply the presented mitigation options should be representative of the best available and most recent data and floodlines as discussed in Section 5.1.

The Municipality of the District of Guysborough Land Use Bylaw establishes watercourse setback requirements for different zones. The land use by law has not incorporated climate change into the regulations at the time of the assessment. Certain building structures require horizontal setbacks from hazard lands, defined within the by law to include lands which may be susceptible to flooding or erosion.

Designated “special policy areas” (SPA) can be enacted, where development below applicable flood elevations can proceed if flood proofing or protection measures are incorporated.

Today, there is no nationally adopted standard (under the National Standard of Canada by SCC-accredited standards) on flood resilient community and building design (for residential construction) that accounts for flooding due to climate change in Canada (Moudrak, 2019). The Nova Scotia Coastal Protection Act was enacted at the time of the assessment, however, no applicable regulations were approved, refer to Section 2.3. The Nova Scotia Coastal Protection Act and all applicable regulations should be referred to in all final decision making processes.

Private residential or lot-level improvements are outlined in CSA-Z800-18 which is a standard on basement flood protection and risk reduction measures (Moudrak, 2019).The National Research Council of Canada (NRC) is currently researching flood resilient building designs under the “Climate-Resilient Building & Core Public Infrastructure Initiative” (CRBCPI) project and have announced updates to the 2025 National Building Code (NBC) which will include climate change.

Table 5.6: Options for Reducing Flood Vulnerabilities

Action	Cost/ Level of Effort	Notes
Enact a policy (for example, within the *Municipal Planning Strategy*) based on designated flood elevations	Moderate - High	Policy can include prevention or adaptation by stipulating a minimum slab elevation above freeboard. Policy should consider limiting the Municipalities exposure by waiving liability for development below the flood line.
Consider future flood elevations in the construction or upgrade of new infrastructure	Low	Existing flood impacted infrastructure is presented on the Flood Maps in Appendix A of this report. Newly constructed infrastructure planned in flood risk areas should consider the feasibility of a flood resilient designs strategy.

Beyond prevention of new risk to new development within areas at risk of flooding, the strategies available to buildings and individual properties are generally the same as those possible for critical utilities, namely to protect, accommodate, or retreat (see Figure 5-21).

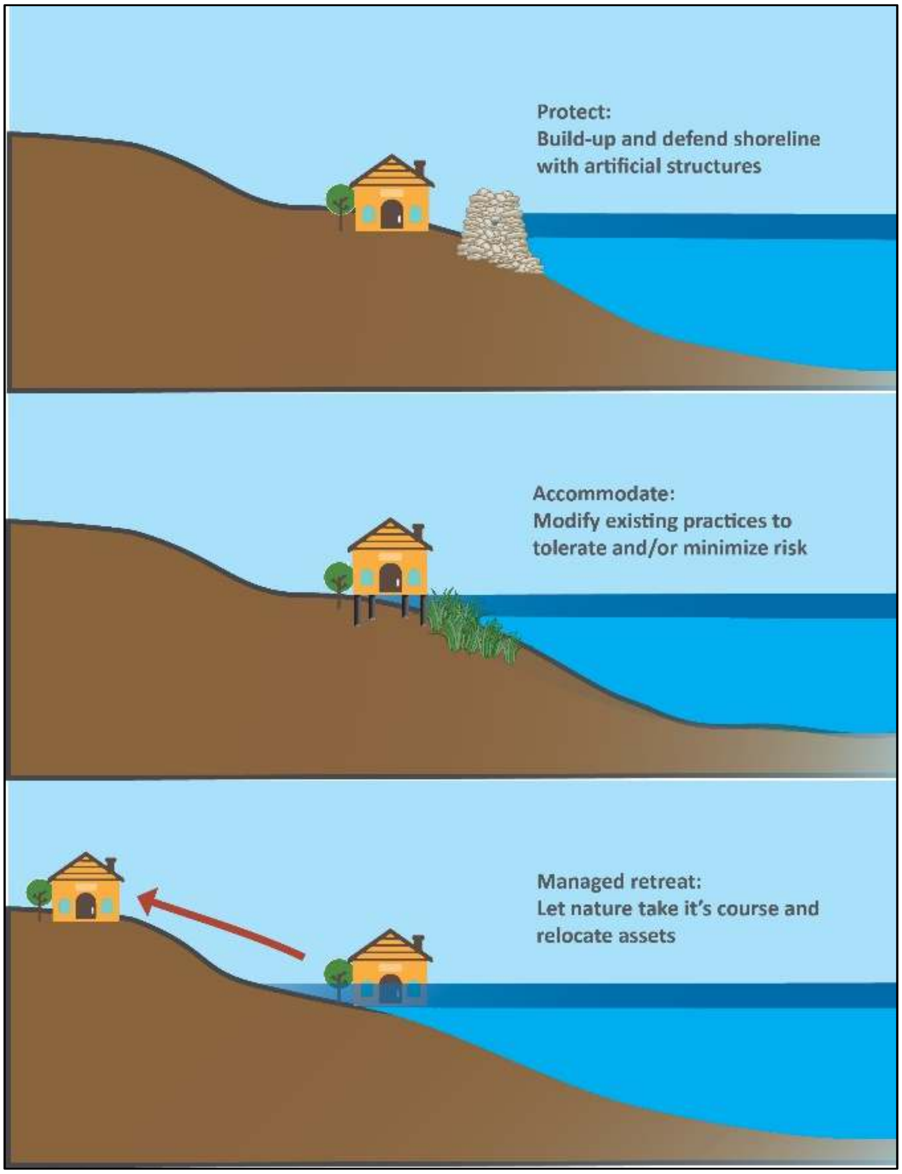


Figure 5-21 Mitigation and Adaption Options for Buildings

5.6.2 Retreat

Relocation of the building outside of the floodplain will greatly reduce the risk of flooding to the building. This mitigation option involves moving the building to higher ground or outside of the floodplain. This option requires access to a new site outside of the floodplain to locate the building. There are two main ways relocation takes place; disassembling the building and reassembly at the selected location, or transporting it the whole structure. To move a structure whole, the building must be raised and transported by rails or flatbed trucks to the final destination. Cost will be dictated by the distances of transportation and the complication of removal or disassembly/reassembly.

Over the short-intermediate terms, the experiences of other Canadian jurisdictions suggest that, as insurance claims on flood damage increase with severity and frequency of flood events, it may become more cost-effective to expropriate and compensate affected properties and encourage moving to less vulnerable locations. Over the long-term (100 years) as a significant portion of the Municipality's settled coastline becomes permanently flooded, abandonment of affected properties and buildings may therefore become a reality. As such, the Municipality is encouraged to start the discussion and planning of what its communities may look like at that time, considering the loss or abandonment of much of the current built environment.

5.6.3 Accommodate/ Adapt Existing Infranstructure

Adapting existing infrastructure to flooding vulnerabilities involves modifying construction to increase resilience to flood events. Site specific flooding vulnerabilities should be determined in order to apply particular accommodations to mitigate risk. Development within the floodplain can be adapted to by locating essential systems or infrastructure off the ground floor, or by prescribing a minimum elevation, ex. minimum freeboard above applicable coastal flood elevation. The building may be raised on pilings or extending the foundation walls to above flood elevations. Furthermore, securing the building foundation, such as on pillars, will further protect the building from coastal erosion depending on the proximity to the coastline. Basements may be abandoned if they experience frequent flooding impacts (Lamond, 2017).

Residential homes within the sea level rise and storm surge flood boundary are at risk of basement flooding. High water levels from extreme precipitation events alone or in combination with high sea levels may also cause sewer backups to the basement. A flooding event in the storm sewer system is characterized by surcharge conditions, where the flows entering the system exceeds the pipe capacity and may back up into homes. Surcharging not only occurs when the flow entering the system is higher than the system is designed to convey, but also when there is a blockage or deformation in the pipe. When surcharging occurs in a combined sewer or wet sanitary sewer, there is a risk that basement flooding can occur in nearby residents where water backs up though the sewer lateral.

General approaches towards flood proofing of individual buildings including raising the house off the foundations, wet flood-proofing and dry flood-proofing. While raising a typical wood-frame house with crawlspace and basement may run in the $60,000 - $100,000 per house, basements may be proofed against occasional flooding for $20,000, or rebuilt with waterproofed foundations for $50,000.

There are property level adaptations that can protect a home from sewer backup. Backflow valves can be installed on sewer laterals, however if the residential drain tile and/or roof leader is connected to the sewer lateral, then the backflow valve may not protect the home effectively. In this scenarios, it is important to disconnect the downspout from the foundation drain before installing a backflow valve.

Overland flooding typically occur on a property due to poor grading away from the home or if the property sits low relative to an adjacent ditch, stream, or river. Damaged or non-existent weeping tiles, cracks in the foundation, or ingress through basement windows are all potential sources of water infiltration into the basement from overland flooding.

The following list outlines adaptation options which may prevent basement flooding in the event of extreme storm events and increased water levels.

1. **Foundation Grading**: Sites that are located in areas that are on or at the bottom of slopes may experience a higher potential for flooding from runoff. Proper grading of the property away from the foundation at a minimum slope can improve drainage away from the home and prevent flooding and associated damage. Reverse driveways should also be avoided if possible.
2. **Installing Sump Pumps**: A backup power source or generator may be required to keep the sump pump in operation during power outages. The sump pump discharge point should be at least 2 m away from the foundation.
3. **Gutters and Downspouts**: Water runoff should be diverted at least 3 m from the roof away from the foundation. Installation of a back-flow preventer on sewer lateral (if applicable).
4. **Repairing Cracks in Foundations:** The cracks or openings may be sealed with a waterproof sealing material such as an epoxy resin to prevent infiltration.
5. **Window Wells Installation:** Installation of window well covers on basement windows can prevent flooding. It is recommended that basement window wells extend 10-15cm above the surface of the ground and are sealed at the foundation.
6. **Alternative Insulation Materials:** Spray foam is the preferred insulation material if the basement is not finished. When a basement is finished, then spray foam insulation may not be practical. An adaptive measure against water damage in basements is to select a closed cell foam insulation (cellulose) which is water resistant for installation at or below grade. A waterproofing sealant on the exterior of basement walls to protect the insulation may also mitigate losses from flooding or water infiltration.

5.6.4 Protect Existing Development

Protection of existing buildings involves construction of engineering solutions to prevent flooding. Protective actions to avoid water infiltration to buildings involves landscaping with extensive landforms, improved drainage, retention features, and structures to barriers such as dykes or walls. During projected flooding events, temporary water exclusion technology may be adopted such as sandbags and homemade flood boards to exclude water during an emergency to extreme sea level events (Lamond, 2017). Conceptual cost estimates of a 2.5m seawall run in the order of $2,500 per linear m.

5.6.5 Proceed

Once a site survey has been undertaken on the vulnerable building, all mitigation options presented may be evaluated. If the mitigation options presented are not feasible at the location, the owner may take no actions and accept the inherent flood risks and potential loss of the building. This option may be adopted if the adaptation measures are deemed to be more costly that the asset itself.

In the case of new development, in the absence of enactment of special policy areas and flood plain overlays, development may be permitted if development proponents waive the Municipality’s liability. This is indeed an option adopted in a number of other jurisdictions.

CHAPTER 6 **CONCLUSIONS**

The results of the risk and vulnerability assessment presented in this MODG Flood Mitigation Plan are reflective of the best available flood information and asset inventories available at the time of assessment. Input and contributions from Municipal staff and officials, greatly improved the quality of this plan and allowed for a comprehensive assessment that is tailored to the needs of the MODG. The Mitigation Plan presents a preliminary analysis of flood risk potential with a number of adaption and mitigation options available for the highest risk impacts to the municipality. MODG may opt to move some of the recommendations outlined in this Plan forward to further study or preliminary design. This plan provides an added layer of information towards the Municipality's development of an action plan for mitigation of flood risks and adaptation of vulnerable critical infrastructure.

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APPENDIX A

Flood Mapping

APPENDIX B

Risk Assessment Matrix

Asset	Sea Level Rise Scenario	MSLER	HTER	HTERSS
	Likelihood of Occurrence	3	2	1
	Severity			
Environmental				
Parks	1	3	2	1
Beaches	1	3	2	1
Trails	1	3	2	1
Tracks	1	3	2	1
Infrastructure				
Buildings	3	9	6	3
Roads	3	9	6	3
Canso Substation	3	9	6	3
White Head Substation	2	6	4	2
West Cooks Cove Substation	2	6	4	2
Railroad	2	6	4	2
Bridges	2	6	4	2
Country Harbour Ferry Terminal	2	6	4	2
Properties	1	3	2	1
Culverts	1	3	2	1
Manholes	1	3	2	1
Pipeline	1	3	2	1
Transmission Line (electrical)	1	3	2	1
Tank (6-15m diameter)	1	3	2	1
Tower (all except transmission line towers)	1	3	2	1
Canso Fire Hydrants	1	3	2	1
Leases	1	3	2	1
Heliport	1	3	2	1
Economic				
Wharfs	3	9	6	3
Martin Marietta Quarry at Aulds Cove	3	9	6	3
Pieridae Energy LNG Terminal	3	9	6	3
Vulcan Materials Tidal Quarry	3	9	6	3
Melford Atlantic Gateway Container Terminal	3	9	6	3
Campground	3	9	6	3
Lumber Mill	2	6	4	2
Cultural				
Churches	2	6	4	2
Community Halls	2	6	4	2
Comfort Centers	2	6	4	2
Recreational Facilities	2	6	4	2
Museums	2	6	4	2
Playgrounds	1	3	2	1
Cemetery	1	3	2	1
Golf Course	1	3	2	1
Shooting Range	1	3	2	1
Municipal Services				
Guysborough Wastewater Treatment Plant	3	9	6	3
Dover Wastewater Treatment Plant	3	9	6	3
Canso Wastewater Treatment Plant	3	9	6	3
Lift Stations	3	9	6	3
Dover Fire Station	3	9	6	3

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