LAND USE PLANNING AND FLOOD RISK MANAGEMENT:

A GUIDANCE REPORT FOR CONSERVATION SUDBURY

DECEMBER 2020

Queen's UNIVERSITY

FOREWARD

This report was written by second year master's students at the School of Urban and Regional Planning (SURP) at Queen's University in Kingston, Ontario. This report reflects the research findings for the course SURP 825: Environmental Planning Project Course. The recommendations put forward by the project team are intended for the use of Conservation Sudbury and are not endorsed or reflective of the positions of SURP, Conservation Sudbury, or Queen's University.

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EXECUTIVE SUMMARY

The flooding of cities and communities has historically caused unforeseen and significant impacts to people, land, and infrastructure. Flooding often occurs during events such as storms, spring ice melts, and other natural disasters. These occurrences can vary in duration, intensity, and frequency to result in severe cumulative impacts. The history of flooding in Canada and across the world has been exacerbated in recent years due to climate change and rapid urbanization. More now than ever, Canadian communities need economically and environmentally viable methods to combat the increased frequency and associated cumulative impacts of flood events.

Land use planning has been identified as the most effective local level tool to address flooding and the associated impacts of climate change in communities. Land use tools such as development restrictions and action plans which address flood risk management and climate change are some of the critical methods used in flood risk management and land use planning. However, many Canadian cities and communities currently lack the tools, research, or knowledge to develop and implement policies and plans which address current flooding impacts. In Ontario, these land use tools and policies are often utilized and implemented by conservation authorities (CAs). Conservation authorities are mainly responsible for undertaking watershed-based programs to protect people and property from flooding and other natural hazards, and for the conservation of natural resources for economic, social, and environmental benefits.

Conservation Sudbury is one of the 36 conservation authorities located in Ontario. The CA covers three major watersheds which encompass the City of Greater Sudbury and extend into private and government held lands beyond the borders of the City. Within each of the three watersheds there are various waterways and waterbodies in a mixture of lands, ranging from an urban city core to rural farmlands. Conservation Sudbury is one of the many conservation authorities which lacks updated policy and plans which reflect current day flood risk management and land use planning techniques and tools. This report intends to address these issues and provide Conservation Sudbury with a list of recommendations which will better inform the development of current land use planning and flood risk management policy within the City of Greater Sudbury and surrounding regulated areas.

To achieve the final recommendations, multiple research and study methods were utilized. First, research on the background information and current flooding conditions in Conservation Sudbury's jurisdiction was conducted. This was followed by an in-depth

review of current land use planning policy and regulations which impact the development of policy and practices relating to flooding and land use. This research was utilized to inform multiple criteria-based case study analyses. The case study analysis includes the review of 19 conservation authorities and two case studies outside of Ontario. An evaluation matrix was utilized to score the case studies based on how well they met multiple criteria in the areas of climate change, participation and engagement, Integrated Flood Management practices, and policy delivery and evaluation. Based on the quantitative and qualitative analysis, a list of key takeaways was developed for each case study. These key takeaways were summarized as a set of final recommendations to be utilized by Conservation Sudbury to develop future policy.

The final recommendations of this report relate to four major themes of Integrated Watershed Management, Stakeholder Engagement, Website Design, and Monitoring and Evaluation. The Integrated Watershed Management recommendations are meant to encourage Conservation Sudbury to take a more proactive approach to land use planning and flood risk management as opposed to a reactive infrastructure-based approach. This included recommendations such as developing an Integrated Watershed Management Plan and adopting a climate change lens in policy to link stewardship and other activities to flood impacts. Stakeholder Engagement recommendations were included in an attempt to bring other stakeholders together with a focus on other regulatory bodies, for a more holistic approach. Examples included identifying additional stakeholders for potential partnerships and considering the formation of a watershed subcommittee with representation from all stakeholders. Website Design and Public Engagement were recognized to not be directly related to land use planning; however they were included as they ultimately affect the day-to-day implementation of land use planning. Examples included making the development application process clear and transparent for the public and making all non-confidential flood management documents publicly available through an online resource. Lastly, Monitoring and Evaluation was recommended as these additions have potential to assist Conservation Sudbury in prioritizing and accomplishing their action items, as well as clearly communicate to their stakeholders the work the Authority is doing. Examples included publishing an annual program review and including measurable deliverables and specific timelines in future strategic plans to track progress towards action items.

Overall, the report successfully uses an evidence-based analysis of land use planning best practices as they relate to flood risk management to develop final recommendations which are grounded in theory and exemplary case studies. It is suggested that the recommendations and conclusions found within the report be applied by Conservation Sudbury to further inform and develop land use planning policy, programs, and plans.

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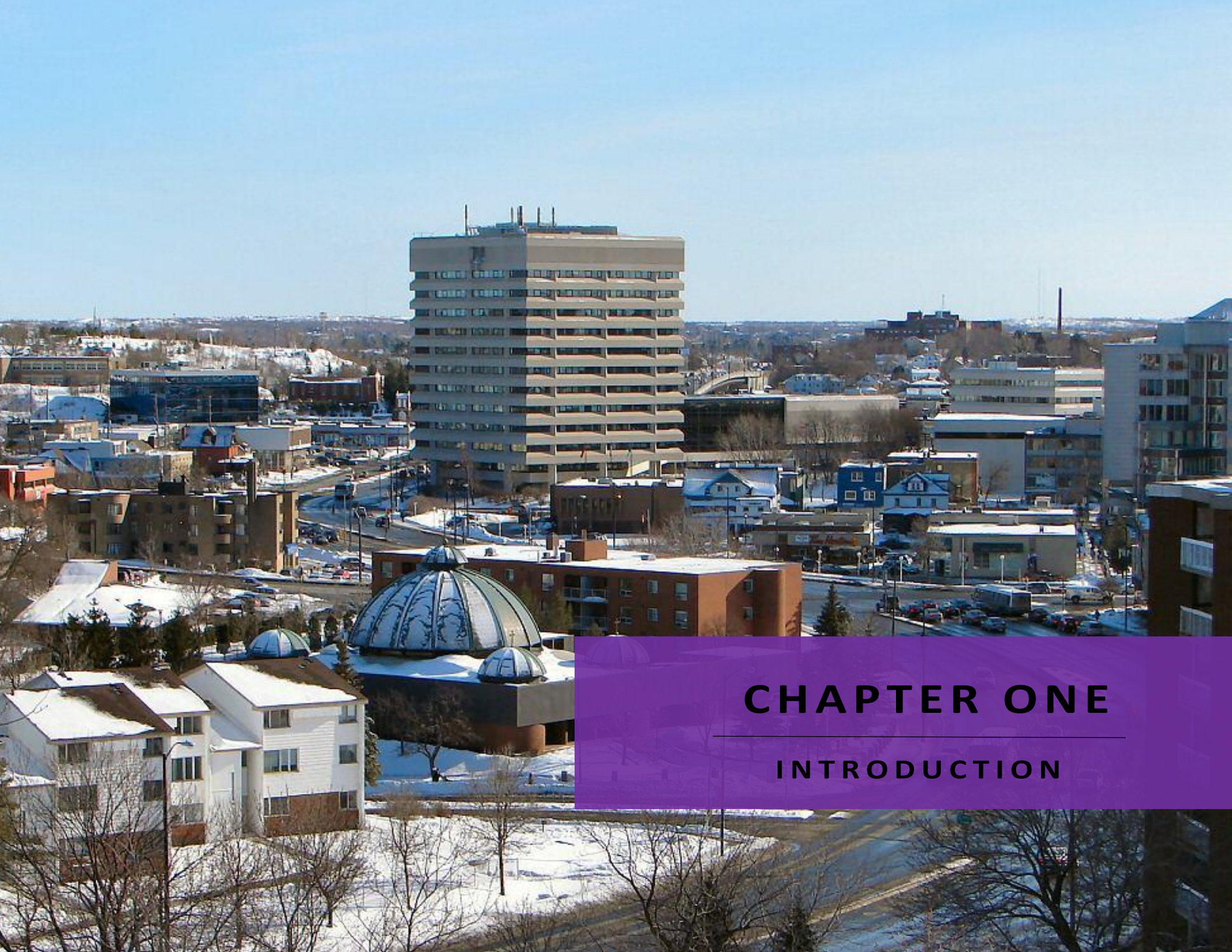


CHAPTER ONE

INTRODUCTION

1.0 Introduction

The following will introduce the purpose and intent of this report. It will outline the vision and goals which have been developed to guide the report and its contents, as well as the methods used throughout research, analysis, and composition. It will also define the main stakeholders and contributors to this report for information of the reader. Detail will be provided throughout the report on all sections outlined in the introduction.

1.1 Report Purpose

This report was compiled to identify land use planning tools that can be applied to flood risk management practices within the jurisdiction of Conservation Sudbury. These tools were developed into recommendations for Conservation Sudbury to update existing policies and practices. The relationship between flood risk management and land use planning is outlined and discussed throughout the report.

This report evaluated projects in other jurisdictions to provide examples of alternative land use practices, then summarized these findings to present the best planning tools and practices for flood risk management. This summary made use of case studies, which were evaluated using a criterion-based approach. This approach evaluated the case studies using an evaluation matrix consisting of specific criteria within four major categories. Each criterion were assigned pre-determined scores, allowing for an objective comparison across case studies. This approach also made it possible to compare both the overall scores of individual jurisdictions, as well as the scores of the four major categories related to flood risk management and policy. The importance of current critical factors in flood risk management such as climate change and risk-based approaches were highlighted and are discussed in depth throughout the report. This report proposes a final set of recommendations supported by analysis of the case studies. These recommendations may inform future land use and flood risk management policy development by Conservation Sudbury.

1.2 Contributors

1.2.1 Conservation Sudbury

This report has been prepared for use by Conservation Sudbury (CS). Conservation Sudbury (also referred to as the Nickel District Conservation Authority) is one of the 36 conservation authorities in Ontario. Conservation authorities (CAs) were implemented by the Government of Ontario in 1946 under the *Conservation Authorities Act*. Conservation authorities are responsible for undertaking watershed-based programs to protect people and property from flooding and other natural hazards. They are also responsible for the conservation of natural resources for economic, social, and

environmental benefits. They work alongside local and provincial governments to establish programs to protect people and property from natural hazards such as flooding. One of Conservation Sudbury's major tools for protecting people and property from flooding and natural hazards is the ability to regulate development in areas prone to flooding. These regulations comply with and enact provincial land use planning policies, as expressed in the *Provincial Policy Statement* (PPS) and the *Planning Act*. Based on these responsibilities, this report will provide Conservation Sudbury with a set of land use planning recommendations, which may be utilized to inform updates to existing internal policies. These recommendations will allow Conservation Sudbury to develop policies which consider both local interests and provincial policy in order to produce effective flood risk management practices.

1.2.2 Queen's University

This report has been prepared by a team of eight master's students at Queen's University's School of Urban and Regional Planning in Kingston, Ontario. This report has been prepared under the guidance of and in consultation with the Conservation Sudbury planning department. The information provided in this report is grounded in research and analysis of municipal, provincial, and federal documents. The recommendations provided by the team are justified and based on research provided throughout this report and do not reflect the opinions of individual members of the team. The team and School of Urban and Regional Planning aims to supply a document which provides broad recommendations to assist Conservation Sudbury in developing future policy. The recommendations in this report are not intended to be formal policies and are only for the use of Conservation Sudbury and associated organizations.

1.3 Vision

The vision of this document is to aid in mitigating the effects of future flood events exacerbated by climate change in the watersheds regulated by Conservation Sudbury through collaboration with community stakeholders and by applying the most effective, evidence-based land use practices.

1.4 Guiding Principles

The guiding principles for this document were selected through background research as factors which play a significant role in flood risk management and land use planning policy. They are applied throughout this document to determine effective land use planning concepts and case studies that may be applied by Conservation Sudbury to manage flood risk. To be successful, it was determined that principles drawn from other projects and plans should:

1. Prioritize public health and safety and damage to property when executing and developing land use planning tools.
2. Recognize the core mandate of conservation authorities to undertake watershed-based programs to protect people and property from flooding and other natural hazards, and to recognize the delegated permitting role of CAs under section 3.1 of the *PPS* and section 28 of the *Conservation Authorities Act*.
3. Recognize the impacts of climate change on flood events and adopt policies that prepare for the impacts of a changing climate.
4. Engage in consultation throughout the planning and execution processes by involving the public, Indigenous groups, appropriate government agencies and other relevant stakeholders. A positive working relationship between these actors should also be cultivated.
5. Adopt a risk-based approach to flood management, prioritizing preventative and mitigative land use planning tools and other non-structural interventions.
6. Monitor the effectiveness of the plan or project and re-evaluate its goals and targets accordingly. This includes considerations such as timeline of implementation, effectiveness of initial goals compared to results, and community acceptance of plans and projects for flood mitigation and management.
7. Consider the local context in relation to geographic location, urban characteristics (population, population density, urbanized area), presence of flood hazard zones, and other factors which may influence the impacts of flooding and the implementation of flood risk strategies.

1.5 Methods

The methods involved in this report consist primarily of a research-based approach to collect, filter, and apply information from multiple sources to this study. This included the use of published scholarly articles, municipal, provincial, and federal planning policies and documents, as well as other published resources from flood authorities. The stages of research and analysis used to produce the final recommendations are provided in Figure 1.

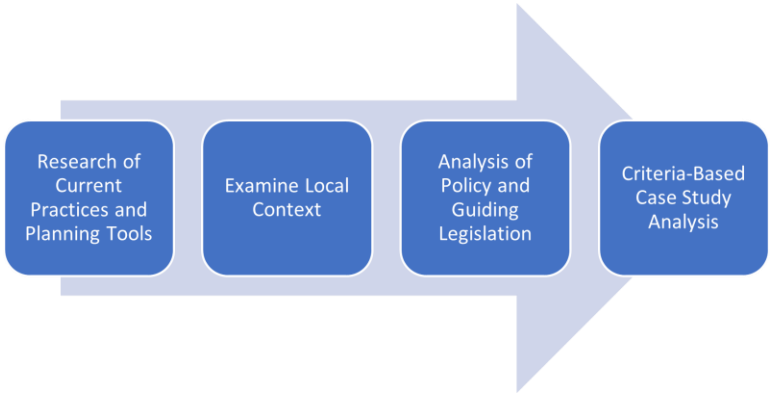


Figure 1: *Report research process.*

First, information was gathered on current planning practices and tools which are used in relation to flood risk management. This included analysis of the current challenges facing flood risk management and the significance of its use within communities. Second, an examination of the local context in the City of Greater Sudbury (CGS) was conducted including a SWOT analysis of the strengths, weaknesses, opportunities, and threats, which are posed in relation to flooding and management. Third, an analysis of policies and guiding legislation in planning and flood risk management were analyzed from municipal, provincial, federal, and international perspectives. The Government of Ontario flooding strategy identifies that one important step to promote sound land use planning for flood risk management is to review existing policy and the ideological approaches of existing guidance. Therefore, this review was identified as an important stage for this report (Government of Ontario, 2020). Lastly, a large criteria-based evaluation of multiple case studies was performed. Case studies evaluated were primarily from Ontario since they operate within a similar regulatory environment. A select few case studies were also included from outside of Ontario.

These case studies were measured against a specific set of criteria relating to the initial principles of the project. The case studies were qualitatively analyzed and given a quantitative scoring based on how well they met specific criteria. A range of weighting was given to different criteria based on the importance to land use planning and flood risk management. Using the scoring system, total scores and category scores were summarized for each case study and the applicability of the techniques and land use planning tools to Conservation Sudbury were determined.

Throughout this research and evaluation process, it was acknowledged that the local context of the study area would limit the applicability of some concepts and tools. The research team identified these limitations in order to filter out unrealistic case studies and programs, and modify recommendations to suit Conservation Sudbury's capacity.

- Differentiation between regions relating to funding and funding resources relating to flood risk management (i.e. information pertaining to municipal, provincial, and national funding sources).
- Topography including elevations, proximity to water bodies, and different land uses which impact what practices may be applied.
- Differences in governance structure and planning authority, as well as the responsibilities and powers of these actors.
- Differences in the legislative or policy context related to environmental compliance and development within hazard lands.

CHAPTER TWO

DEFINING THE PROBLEM

2.0 Defining the Problem

This section of the report introduces the general problems of flooding and the importance of flood risk management. As summarized by the Canadian Centre for International Governance Innovation "flood losses are widely expected to increase in the future, due to population growth and expansion of economic activities in flood-prone areas, as well are more frequent and severe extreme weather triggered by climate change" (Henstra & Thistlethwaite, 2017). These current global issues driving demand for flood risk management, and the main considerations necessary for effective land use planning to mitigate flood risk will be further outlined in this section.

2.1 Public Health and Safety

For nearly 75 years CAs have managed the province's natural resources and have an extensive record of protecting people and property from water-related natural hazards. The Conservation Authorities Act outlines some of the top priorities for CAs which include preventing loss of life, minimizing property damage and social disruption, controlling development as it relates to pollution of water resources, and reducing public and private expenses associated with emergency operations for flooding (Government of Ontario, 2015). The specific powers of the CAs are outlined in section 21 of the *Conservation Authorities Act*, specifically in relation to flooding in section 21(j) which states that "for the purposes of accomplishing its objects, an authority has power, to control the flow of surface waters in order to prevent floods or pollution or to reduce the adverse effects thereof" (Government of Ontario, 1990). These priorities and powers indicate that CAs value the physical, social, and economic wellbeing of communities and the individuals which inhabit them.

The PPS also highlights the protection of public health and safety as a top priority for the Province, planning authorities, and conservation authorities (Provincial Policy Statement, 2020). To achieve this, the potential for natural or human-made hazards that present a threat to residents or result in unnecessary public expenditures must be reduced. This includes mitigating the potential risk from natural hazards that currently exist, as well as preparing for future risks associated with climate change. The PPS outlines general directions for development within and adjacent to specific hazard areas as seen in section 3.1.1(b) which includes "…hazardous lands adjacent to river, stream and small inland lake systems which are impacted by flooding hazards and/or erosion hazards…" (Provincial Policy Statement, 2020). These restrictions are used to mitigate flood risks and protect public health and safety.

2.2 Definitions and Current Issues Relating to Flood Risk Management

Flooding occurs during events such as storms, large ice melting events, and other natural disaster events. It can vary in scale from water level increases along a creek in a forest or backyard, to large surges of water from oceans, lakes, and rivers. Flooding has the ability to cause severe impacts to valuable human assets such as homes, businesses, public spaces, wildlife and habitat, and even human life. In Canada, overland flooding causes the greatest financial impact to national resources and funding out of any other hazard nationwide (Government of Canada, 2019). The 2013 Southern Alberta flood, for example, resulted in 5 deaths, thousands of destroyed homes, over 100,000 people evacuated, and approximately $6 billion in damages (Burton, 2015). These types of flooding events have immediate and long-term impacts to communities and individuals that occupy them for years after they occur. Having a knowledge of the impacts and effects that flooding has on individuals, communities, and governments can help to prevent the severe damages associated with them. One of the important steps to this is understanding and acknowledging flood risk management and related concepts and their role in preventing these disasters from occurring.

2.2.1 Flood Risk Management

Flood risk management is comprised of the direct efforts within a community or region to prevent, reduce, or eliminate the risk and impacts of flooding events (Government of Ontario, 2020). Flood risk management uses multiple tools and approaches within different geographic regions to address flooding. It depends on factors such as topography, climate, economic opportunity, governance, environmental conditions, social acceptance, and many others.

The current approach to flood risk management in Ontario has four core components, as seen in Figure 2, with the objectives of saving lives and money, protecting property, public health and the environment, maintaining economic stability, helping ensure the continued use and maintenance of critical infrastructure, and reducing social disruption during emergencies (Government of Ontario, 2020).

These core components are significant in managing flood events and planning; however, this report will focus primarily on mitigation and preparedness of floodplain management and the role of land use planning and policy.

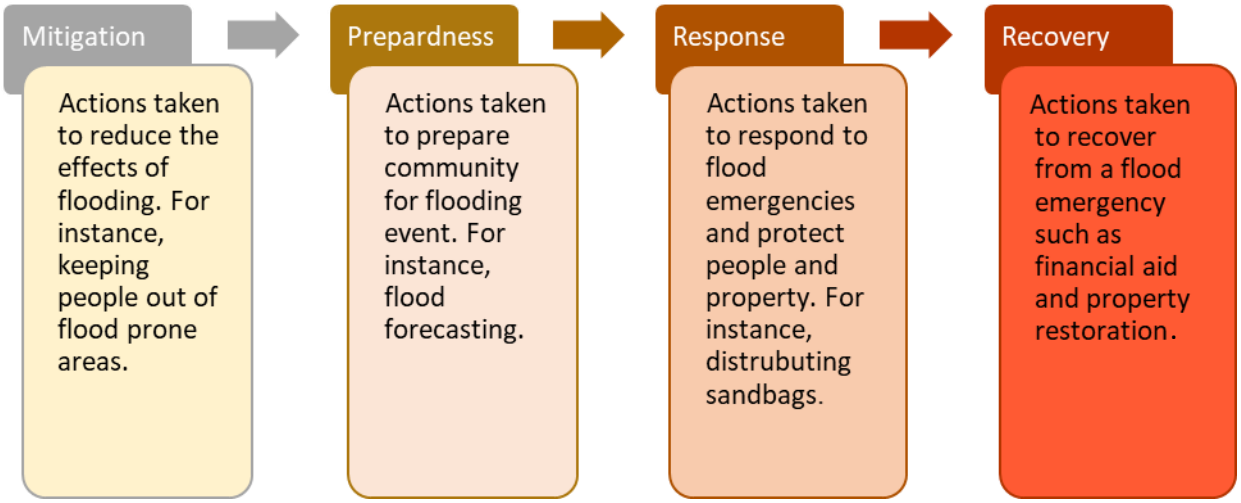


Figure 2: *Government of Ontario flood risk management approaches.*

2.2.2 Watersheds and Floodplains

A watershed "means an area that in drained by a river and its tributaries" according to section 6.0 of the PPS (Provincial Policy Statement, 2020). Watersheds are significant in identifying the path of waterflow and therefore vital in predicting flooding based on quantity and direction of water from all areas within the watershed. Figure 3 shows a typical watershed and associated elements such as rainfall, overland flow, and underground water flow which all drain to the lowest elevation within the watershed, typically a river, lake, or body of water.

Watersheds are important for flood management as they often cover a larger area than individual municipalities and incorporate multiple of them. Knowledge of these contributing municipalities within a singular watershed is important for management of the watershed as whole in relation to climate change, water flows, and flooding.

Within the watershed, there are major components which contribute to understanding flooding and flood risk management such as the floodplain, floodway, and flood fringe. As defined in section 6.0 of the PPS, a floodplain is "for river, stream and small inland lake systems, means the area, usually low lands adjoining a watercourse, which has been or

may be subject to flooding hazards" (Provincial Policy Statement, 2020).

The floodplain consists of two major parts; the main channel, referred to as the floodway, and the surrounding flat area of land often impacted by increase in water levels, known as the flood fringe. Figure 4 outlines the relationship between the extent of a floodway, and flood fringe. Definitions for these terms can be found in the Glossary at the end of this document.

Areas which are under the control of the federal, provincial, and municipal government often have mapping and information available to the public to determine which areas are within floodplains and are at risk. To be involved in the flood management process, it is important for communities and individuals to identify their associated conservation authority and check if they are within an identified floodplain. This allows individuals to better prepare and understand how they can be involved in the planning of their community and its infrastructure for flood prevention, as well as what actions can be followed during flood events. This information can be found online at the Conservation Ontario website here:

https://conservationontario.ca/conservation-authorities/find-a-conservation-authority.

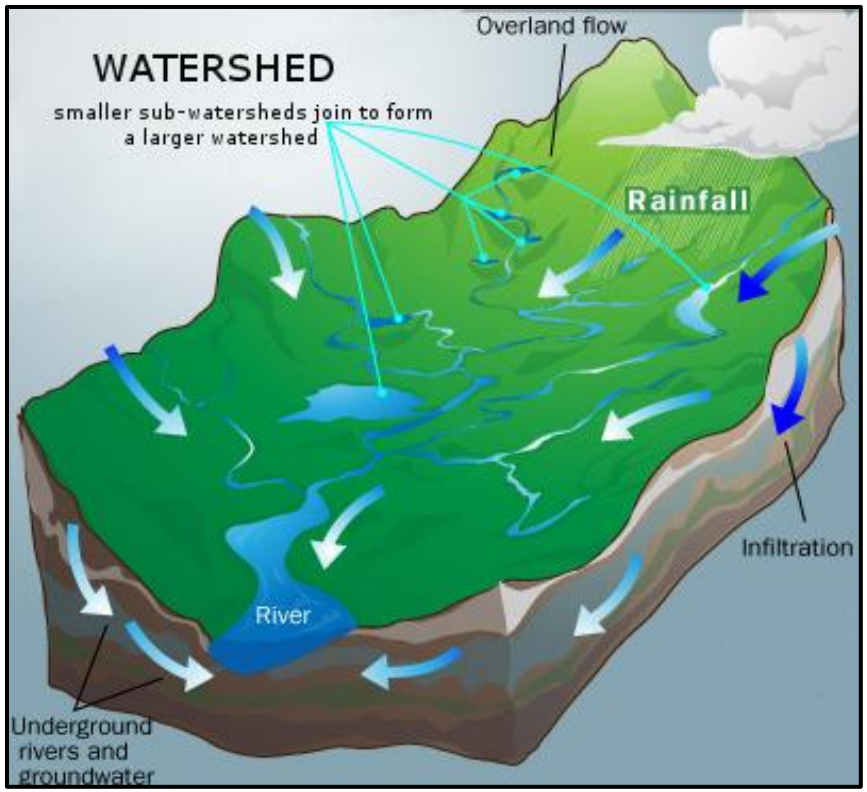


Figure 3: *Typical Watershed Cross Section (Wheatley River Improvement Group, n.d.).*

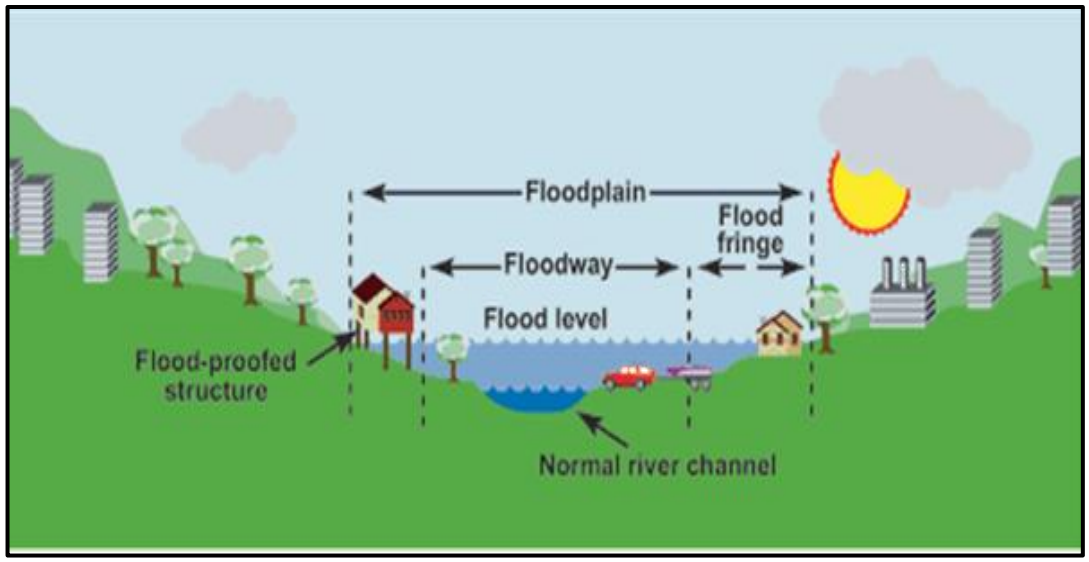


Figure 4: *General flooding terminology diagram (Government of Canada, 2010).*

2.2.3 Types of Flood Events

To better understand the impacts of flood events on the surrounding environment and associated communities, the different types of flood events must be understood. The most common types of flooding in Canada will be discussed here and will be connected to Conservation Sudbury's jurisdiction later in the report. The following types of flooding are the most common across the country (The National Oceanic and Atmospheric Administration):

- **Riverine Flooding** – occurs when water levels rise and overcome the edges of riverbanks from excessive rainfall of persistent storms and/or snowmelt for extended periods of time.
- **Coastal flooding** – caused by higher than average tides along coastal regions and is worsened by heavy rainfall and winds. Many places along the coastline experience shallow coastal flooding several times throughout the year due to development in low elevation areas.
- **Storm Surge** – rise in coastal water levels over regular tide rise levels caused by severe windstorms and

consequent waves. These events cause extremely dangerous flooding and are often the greatest threat to life and infrastructure.

- **Inland flooding** – moderate precipitation over several days, intense precipitation over short time, and river overflow due to ice or debris jams or dam or levee failure.
- **Flash flood –** caused by heavy rainfall over a short period of time, usually characterized by torrents of heavy rain that rips through riverbeds and urban streets. They can also occur due to failure of infrastructure such as levees and dams or release of water by breaking of ice or debris.

The different types of flooding vary in their impacts as well as causes. The origin of these floods can come from multiple different natural or human induced events. Different types of flooding can result from different combinations of causes and environmental conditions. They can vary in severity and frequency, and can produce different physical, social, and environmental impacts on communities. The most common causes of flooding are discussed in more detail in the following section.

2.2.4 Causes and Impacts of Flooding

Types of flood events can occur from one or more causes related to climate, natural disaster events, and human induced impacts or failure. The Government of Canada identifies several common causes of flooding across the country (Government of Canada, 2013):

- **Rainfall –** the natural and regular fluctuations in precipitation during rain events and storms. Flooding caused by rainfall is impacted by the amount, duration, and intensity of rain.
- **Snowmelt Runoff –** increases in waterflow due to large quantities of snow melting in the spring.
- **Ice Jams –** ice breakage along waterways, allowing a large release of water to flow in a short amount of time.
- **Coastal Storms –** examples include tsunamis and hurricanes.
- **Urban Stormwater Runoff –** the impacts of urbanization alter drainage characteristics and natural catchments by increasing volume and rate of surface runoff.
- **Infrastructure Failure –** i.e. dams, hydraulic structures such as water towers, etc.

These flooding events have major impacts on many aspects of social, economic, and environmental well-being as summarized in Figure 5. Social impacts include impacts to overall health and wellbeing of communities, individuals, families, and groups of people. A large component

of social wellbeing comes from the subjective well-being of individuals in flood zones or those who have experienced flood events. Many people and families live in a state of stress and concern due to personal perception of risk caused by flood experiences. This can include personal loss of property, valuables, or even life. Many individuals' flood experiences can have negative impacts on subjective well-being which manifest further over time. These individual social impacts also play a role in the willingness of people and communities to participate in flood risk management and planning (Hudson, Botzen, Poussin, & Aerts, 2017).

Economic stress is also a significant outcome of flood events. Physical damage to items such as housing, public buildings, open spaces, flood prevention infrastructure, and the natural environment often require significant remediation and investment. Many individuals also pay high insurance premiums for their person, home, and belongings when living in flood-prone areas (Moudrak & Feltmate, 2017). A rising issue which has been noted in municipalities is the financial losses associated with development within floodplains and lack of knowledge of the regulations and restrictions. Individuals or businesses often purchase or invest in the development of a land before becoming aware of the flood hazards and therefore development limitations. This economic investment can be seen in the form of land surveys, purchasing of materials, and contract costs which are then lost when development is restricted. As well, the investments required by municipalities and other levels of government to repair and replace damaged local infrastructure can accumulate significant costs and deplete public resources. This includes both immediate and long-term relief and repair. Immediate costs include the provision of community services

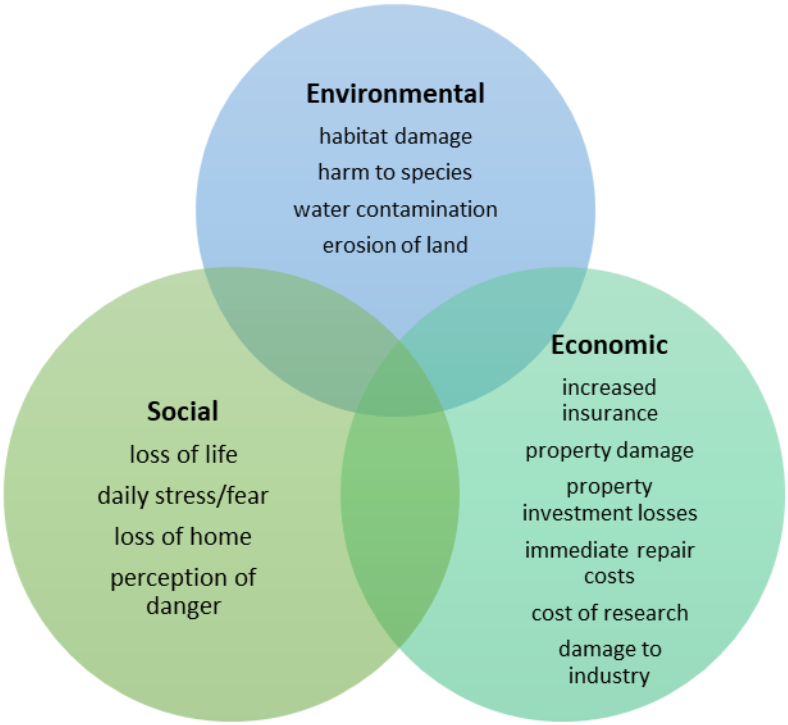


Figure 5: Social, economic, and environmental impacts of flooding events.

such as clean drinking water, food, electricity, and transportation during and after flood events (Hammond, Chan, & Djordjeciv, 2013). Long term costs include investment in flood risk management practices and research, infrastructure repair, and support for those impacted by flood events. Large scale economic impacts also include damage to goods and services which provide income and economic opportunities for individuals, communities, and regions (Hammond, Chan, & Djordjeciv, 2013).

Environmental impacts are related to both social and economic impacts. Damage to the natural environment such as erosion, habitat destruction, waterway contamination, and loss of green space due to flooding all have significant impacts. These types of severe flooding events are not the same as predicted or annual flooding which occurs naturally in many areas. Often flooding has positive impacts from environmental perspectives such as creation of temporary habitats, spawning of seasonal fish, and watering of crops and agriculture which require water coverage. However, these negative environmental impacts are concerned with severe flood events which cannot be controlled and are not typically expected within a community or watershed, therefore have negative repercussions on the ecosystem. Negative impacts such as deterioration of waterways can contaminate the local drinking water supply, making it potentially unsafe for consumption and other uses. Erosion of waterways such as rivers and streams can change water flow strength and velocity, reducing the amount of usable land and impacting both existing infrastructure and future development. Many environments are damaged during flood events which have significant impacts on wildlife and the broader ecosystem. This can cause significant habitat loss, resulting in species migration to new areas. This may have larger impacts on communities which rely on animals and their habitat as a source of livelihood or sustenance (Moudrak & Feltmate, 2017). Damage to environmental resources such as crop fields also have significant long-term impacts to communities and individuals.

Flood events can range from mild to severe depending on personal perceptions of their impacts, as well as the actual consequences of the flood event itself. Flood events produce significant and interrelated social, economic, and environmental impacts. It is vital to acknowledge these interconnections in order to implement practices that reduce harm and impacts to all associated factors. One of the most important tools to do this is land use planning.

2.2.5 Climate Change and Flood Risk Management

Even with significant advancements in land use planning techniques and greater understanding of its importance to flood risk management, the rapidly increasing impacts of urbanization, climate change, and other issues make flood risk

management an ever-evolving issue. Thus, current flood risk management approaches must be incorporated into land use planning practices and policies on a continual basis.

Climate change is one of the most significant issues presently facing the world and planning practices. A changing global climate and its associated environmental impacts have created a need for more adaptive, resilient, and sustainable planning. Land use planning is identified as one of the most effective processes to adapt to climate change on a local level (Richardson & Otero, 2012). One of the significant impacts of climate change has been an increase in extreme weather events including rainfall, precipitation, and freeze/thaw cycles. The intensity, frequency, and impacts of storm events with significant rainfall have been increasing and, consequently, producing more frequent and intense flooding. Historically, the 100-year storm event has been used as a flood safety design guideline. This standard does not actually refer to a size of flood, which only occurs once every 100 years, but rather is a shorthand for a size of flood which has a 1% probability of occurring each year in a given area. Although the 100-year flood was once considered an extreme event for overland flooding, the increased frequency and cumulative impacts of smaller scale flooding due to climate change have begun to create more significant impacts than the 100-year flood has not accounted for. The increased frequency and severity of these events has reduced time to prepare for and recover from the damages caused by flood events. This has placed substantial financial, emotional, and environmental stress on communities and governments.

To address climate change, planners have adopted land use planning techniques that protect water resources and critical infrastructure, increase natural hazard and flood resilience through Low Impact Design and green infrastructure, and restore and protect natural ecosystems (Region of Peel, 2018). Alongside efforts to reduce the impacts of climate change on the global-scale, land use planning is a tool which can reduce these harmful impacts on the local-scale. A more detailed analysis of the tools and land use planning policies related to climate change and flood risk management are outlined in latter sections of this report.

Overall, appropriate land use planning practices and tools can make significant positive changes for communities and infrastructure impacted by flooding from social, economic, and environmental perspectives. On the contrary, poor or nonexistent land use planning within areas impacted by flooding stands to have even greater negative impacts. This paper will address these land use planning policies in further depth and analyze both the successes and failures of land use planning in flood risk management. Understanding the tools which can be used in the area under jurisdiction of Conservation Sudbury and how they may be integrated and used by the community will serve to better inform future

development that promotes health, safety, resilience, and involvement for all members of the impacted communities.

2.2.6 Flood Risk Management Communications and Responsibilities

Monitoring flood conditions and events is a shared responsibility between conservation authorities, the Ministry of Natural Resources and Forestry (MNRF), the Provincial Government, and Environment Canada. Depending on the regional and municipal authority within a geographic boundary, different responsibilities for flooding and risk management are delegated to governing bodies in relation to funding, action, and community outreach and engagement. In the City of Greater Sudbury, Conservation Sudbury holds the primary responsibility to notify and communicate flood risks and events with the public. The province of Ontario provides similar information for larger geographic regions not identified under a conservation authority. These details are outlined below.

Provincial Flood Notification Responsibility

The government of Ontario and its flood notification protocol define flooding and flood messages with specific language which is vital to understanding the risk and hazards present. The provincial flood notification protocol is shown in Figure 6. The province provides 3 types of provincial flood messages (Government of Ontario, 2020).

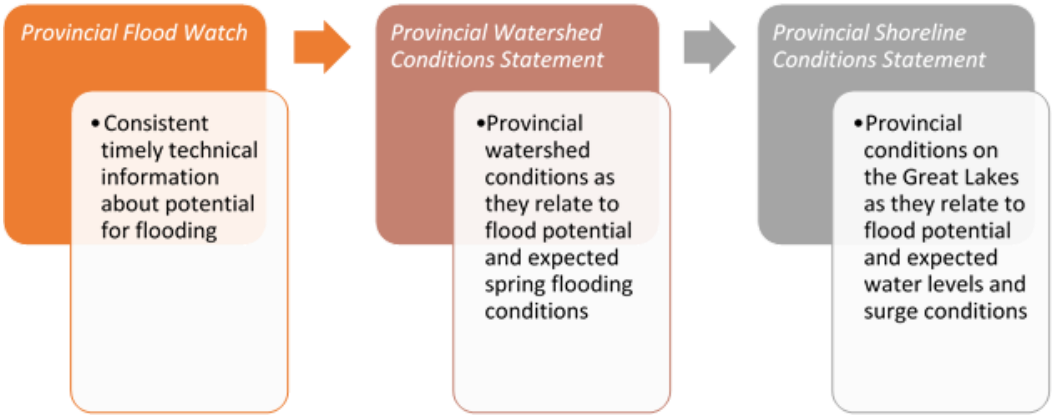


Figure 6: *Provincial flood notification protocol.*

This information can be found on the Government of Ontario website or through the local conservation authority as it is relayed to local authorities through the Surface Water Monitoring Centre.

Conservation Authority Flood Notification Responsibility

Local flood messaging and information, as well as on-the-ground flood response is provided by the local conservation authority. As per Section 20 of the *Conservation Authorities Act*, the primary responsibility of CAs is as follows:

> The objectives of an authority are to establish and undertake, in the area over which it has jurisdiction, a program designed to further the conservation, restoration, development and management of natural resources other than gas, oil, coal and minerals. (Government of Ontario, 2015)

For the residents of Greater Sudbury, local responses, and notifications to flooding events are administered by Conservation Sudbury. Any communities not serviced by a conservation authority are issued flood warnings by the nearest Ministry of Natural Resources and Forestry districtoffice. Local flood messages provided by conservation authorities include those seen in Figure 7 and definitions below (Government of Ontario, 2020).

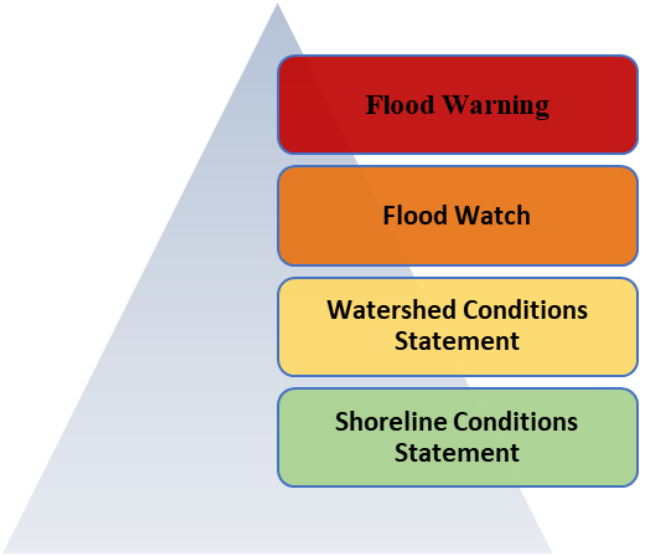


Figure 7: *Conservation Authority flood notification protocol.*

- ***Flood warning*****:** flooding is imminent or already occurring
- ***Flood watch*****:** there is the potential for flooding
- ***Watershed conditions statement*****:** early notice for potential for flooding based on heavy rain, snow melt, etc., and water safety information
- ***Shoreline conditions statements*****:** early notice of the potential for flooding on great lakes based on weather and lake conditions and water safety information

These messages can be accessed via the respective conservation authority website or by calling / contacting the local conservation authority office. During imminent or potential flood risks, this information will often be broadcasted on local news and radio stations for the public. More detailed information on the responsibility of conservation authorities and Conservation Sudbury can be seen in latter sections of this report.

Public Consultation and Responsibility

Flood risk management planning requires the involvement of the public in planning practices and preparation for flooding events. Effective consultation is a priority for planning bodies and conservation authorities to ensure the needs and concerns of the community are being addressed when dealing with issues of flooding and flood management.

Over time, the responsibility of flood risk management has shifted from solely experts to include citizens and communities. This shift acknowledges that there are practical and physical limitations to addressing flooding with techniques such as infrastructure construction and remediation. Due to this a new focus has been placed on individuals and communities to better understand and recognize the potential impacts associated with living in flood zones (White, Kingston, & Barker, 2010). The community plays a vital role in providing information and input to planning exercises for flood risk management such as knowledge of local conditions, potential areas of development concern, and ideas or solutions which may be better integrated within the existing framework and character of an area. To do this, it is important that communities and individuals are aware of flood risks and whether or not they are living in floodplains. Increased public awareness and knowledge of flood risk has the potential to significantly decrease the financial and social cost of flooding. This awareness and knowledge can be cultivated through educational programs which provide accessible resources and information to the public. This consideration will be developed as part of a consultation and engagement analysis found in the appendices of this report.

Public engagement can occur at many levels throughout flood risk management planning processes such as policy development, initial development of regional and official plans, and during development projects and proposals. This report will provide a review of public consultation practices and strategies in relation to the development of future flood risk management policy and associated land use regulations. A detailed review of these public participation practices can be seen in Appendix 4.

2.3 Land Use and Flood Risk Management Relationship

The following sections explain the connection between land use and flood risk management. Specific types of land cover are examined in further detail to show how the infiltration rates and runoff generation volumes differ across land uses as demonstrated in Figure 9.

2.3.1 Overview

Land use planning and regulation of development is the most effective way to manage risks to future development by avoiding hazardous development in flood hazard areas. Land use planning ensures that buildings and other structures are not flood susceptible and that upstream and downstream issues do not occur as a result of new development (Nickel District Conservation Authority, n.d, p.3 ; Queensland Government, 2017). Additionally, land use planning can be utilized to protect existing development through flood-responsive zoning and appropriate assessment benchmarks (Queensland Government, 2017).

Land use changes have been proven to impact flooding through alteration of the natural hydrological processes of river basins. Modern land use practices have reduced the infiltration capacity of soils, which obstructs natural drainage systems and increases the volume and rate of runoff. Further, land use changes impact the frequency, intensity, and general characteristics of flooding. These land-cover changes also disrupt erosion and sediment dynamics (World Meteorological Organization, 2016).

Historically, structural interventions were used to combat flooding. While structural measures are an important piece of flood management, they have a limited ability to control floods and often create a false sense of security (World Meteorological Organization, 2016). Today, land use planning has a vital role to play in flood risk management.

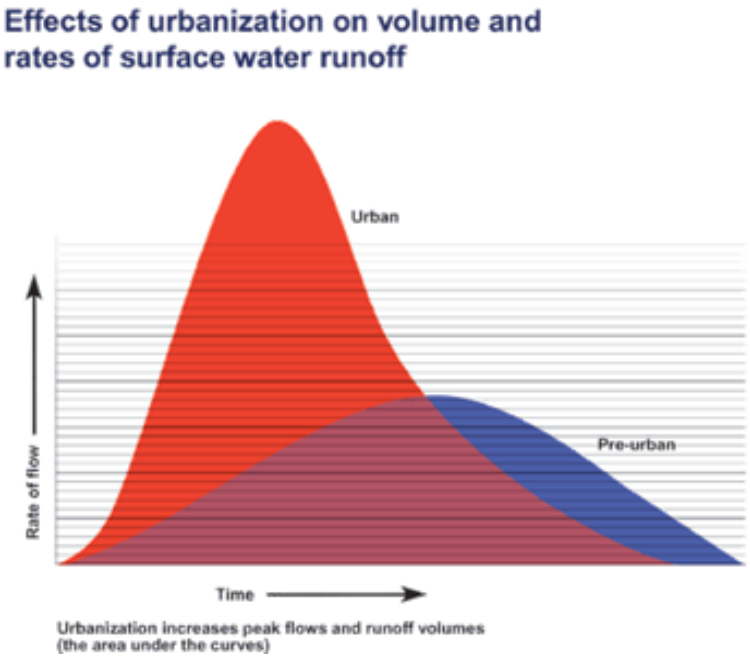


Figure 8: *Relationship between peak water Flow volumes over time between urbanized and non-urbanized lands (Government of Canada, 2013).*

2.3.2 Land and Water

It is important to recognize the relationship between land and water. Flooding is a natural phenomenon that serves a number of purposes such as maintaining biodiversity, fish habitat, and the fertility of floodplain soils (Food and Agricultural Organization of the United Nations, 2005). However, flooding and associated surface runoff also carries pollutants such as pesticides, fertilizers, pathogens, and toxic contaminants which affect soil and water quality (World Meteorological Organization, 2016). In their natural state, floodplains are dynamic and shift over time as the banks of lakes, rivers, and streams erode (Moudrak & Feltmate, 2017). As humans alter land uses in the catchment area, natural systems and processes are disrupted resulting in negative effects. Considerable time lags between land use changes and the associated effect these changes have on the natural processes make some effects difficult or even impossible to identify (World Meteorological Organization, 2016).

2.3.3 Urbanization

As the landscape becomes increasingly urbanized, it is necessary to look at the relationship between urban land uses and flooding. Urbanization can increase the risk of flooding, posing a greater threat to human life and property damage. This is because the hydrological cycle is altered when a previously permeable surface is converted to an impermeable surface (Toronto and Region Conservation Authority, 2014). Removal of vegetation and soil, grading of the land surface, and construction of drainage networks all disrupt natural drainage processes and degrade the soil structure. The degradation of soil structure due to compaction or covering by an impermeable surface reduces storage and infiltration capacity (World Meteorological Organization, 2016). Together these factors put urban areas at a greater risk of flash flooding because the soil does not have the capacity to store the volume of water needed to prevent flooding (refer to Figure 9). This relationship can be seen in the Figure 8 which shows how significantly rates of flow can increase in much shorter periods of time within urbanized versus non-urbanized areas.

Another consequence of urbanization is the erosion of urban rivers. Channels that are straightened to accommodate development can increase flow velocity, allowing greater sediment transport which increases erosion. The volume of water discharged from urban rivers tends to exceed the volume discharged from rural rivers (World Meteorological Organization, 2016). Although many regions have attempted to adsorb the impacts of urbanization through retrofitting and restoration of natural water adsorption, the impacts of climate change in conjunction with urbanized areas are creating worsening conditions. Land use planning practices must aim for a higher standard of resiliency and adaptation in all development to address evolving flood risks due to

urbanization and climate change together (Region of Peel, 2018). Land use planning must now consider flood risk management and ways to reduce the impacts of urbanization to protect people and property.

2.3.4 Agriculture

Agriculture is a land use commonly found within floodplains due to the presence of highly fertile soil. While agricultural land uses may not convert permeable surfaces to impermeable surfaces such as buildings, roads or sidewalks, agricultural land uses do alter natural hydrological processes and influence flooding. Modern agricultural practices degrade soil structure through compaction which reduces the infiltration and storage capacity of soils (World Meteorological Organization, 2016); (O'Connell, Ewen, O'Donnell, & Quinn, 2007). This significantly affects surface runoff generation. Other practices, which leave soils with little or no vegetative cover can result in the formation of a surface crust with little storage capacity and contribute to surface runoff. Plough lines, ditches, and tire tracks then concentrate this overland flow, conveying it quickly to water courses (O'Connell, Ewen, O'Donnell, & Quinn, 2007). Agricultural lands have a greater ability to absorb water than urban environments with impermeable surfaces, however it is important that these lands are also managed to mitigate flooding.

2.3.5 Forest Cover

Forests are an important land cover for mitigating flooding as the porous soils of natural forests tend to have high infiltration rates. This translates to low surface runoff and low rates of erosion (Calder & Aylward, 2006). The undergrowth, roots, and forest litter also play an important role in stabilizing soils to prevent erosion (Food and Agricultural Organization of the United Nations, 2005). Forests alone cannot prevent large-scale flooding, but they are an integral aspect. The loss of vegetation and clearing of forests does increase runoff and erosion, which decreases the soil water holding capacity (World Meteorological Organization, 2016). Figure 9 displays the relative difference of infiltration rates and runoff volumes for different land uses, showing that urban land uses have the lowest infiltration rates and highest runoff volumes, while forests have the highest infiltration rates and lowest runoff volumes.

2.3.6 Wetlands

Wetlands are another type of land cover which directly impact flooding and play a vital role in its prevention. Wetlands are areas that have been soaked with water long enough for the soil to become waterlogged (OMNRF, 2020). These conditions allow for water-loving and water-tolerant plants to grow (OMNRF, 2020). Wetlands protect shorelines from erosion and control and store surface water, as well as regulate the

recharge and discharge of ground water (Lake Simcoe Region Conservation Authority, 2020, p. 63). The ability for wetlands to store water aids in lowering water levels during flood events. The vegetation in wetlands also helps to slow the speed of floodwaters (United States Environmental Protection Agency, 2006). In southern Ontario it is estimated that 70% of wetlands were lost by the late 1960's (Bardecki, 1982). Since this estimate close to 40 years ago, wetland coverage has only been further depleted along with the flood protection services they provide. This dramatic loss of wetlands highlights the importance and urgency for protecting remaining wetlands in Ontario. Greater loss of wetlands coupled with increasing severe weather events resulting from climate change presents imminent pressures that may result in flooding disasters.

2.3.7 Natural Systems, the Built Environment, and Flooding

Utilizing natural systems can help protect against flooding. In addition to conserving forests and properly managing agricultural lands, riparian corridors enable the natural functions of the floodplain to be maintained, providing a protective function during flood events (Queensland Government, 2017). It is therefore crucial to allocate more space to riverine systems (World Meteorological Organization, 2016).

The built environment can also supplement natural landscapes by including components such as parks, trees, green roofs, bioswales, and other green infrastructure (Toronto and Region Conservation Authority, 2014). Land uses can also be multifunctional. For example, outdoor parks and sports facilities can serve as water storage areas in the event of a flood (World Meteorological Organization, 2016).

It cannot be overstated that changes in land cover have a direct and major impact on downstream flooding. Land cover is the most significant variable at a watershed scale that can be shaped by planning and engineering decisions to protect people and property from flooding.

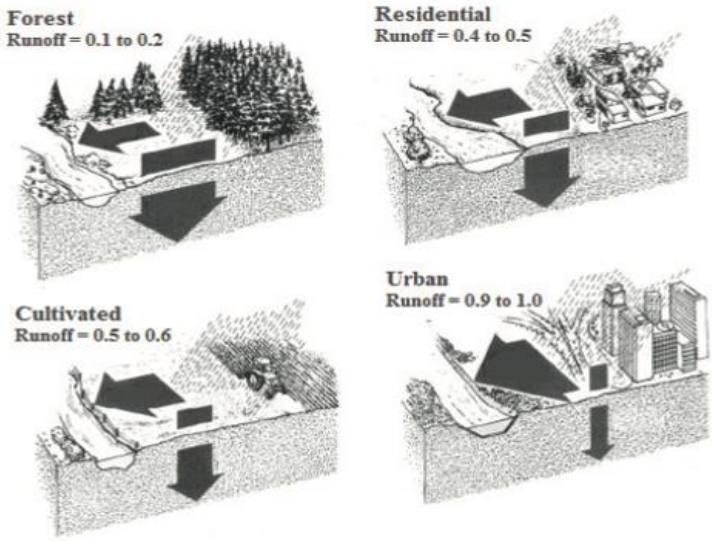


Figure 9: *Relative difference of infiltration rates and runoff volumes for forest, residential, cultivated, and urban land uses (APFM, 2016, p. 15).*

CHAPTER THREE

THEORY AND CONCEPTS

3.0 Theory and Concepts

The following section outlines the guiding theoretical framework and major concepts that are important for flood risk management. These are outlined for informational purposes and to provide justification for the case study evaluations and final recommendations.

3.1 Integrated Flood Management (IFM)

According to the Global Water Partnership, Integrated Flood Management (IFM) is a framework that combines both land and water management. It aims at maximizing the efficient use of floodplains, while minimizing the loss of life and property. IFM applies both risk-based and hazard-based management approaches in its planning (World Meteorological Organization, 2009). A hazard-based approach identifies lands that are prone to flooding and locates development outside of these lands. It only considers the presence or absence of hazards and prescribes uniform responses to each circumstance. Risk-based approaches consider both the presence of a hazard and the relative risk posed by that hazard. For example, a risk-based approach might allow low-risk development such as parks in the floodplain or allow additions to existing properties within the floodplain if these additions do not present a significant threat to loss of life. Another benefit of a risk-based approach is that it acknowledges that development not on hazard lands is not immune to the effects of flooding. Thus, a flood risk management approach can improve flood resilience by commenting on policies affecting development outside the floodplain from a flood management perspective. Although guiding legislation in Ontario increasingly acknowledges the importance of risk-based approaches to flood risk management, existing legislation focuses on a hazard-based approach. The IFM framework used in this report is useful to land use planning because it recommends balancing development needs with flood risks and how to achieve this.

Prohibiting new development in all flood prone areas is difficult due to competing interests such as population growth and urbanization. Source water control and emergency management are traditional flood management practices often applied to development in flood prone areas. These traditional approaches are criticized for giving residents a false sense of security as absolute protection from flooding is unfeasible and environmentally non-viable. More recent approaches to flood management use land use regulations and other non-structural techniques to limit development in flood-prone areas. However, in areas where land is under development pressure, land use controls that regulate activity on floodplains are less likely to be effective.

Integrated Flood Management encourages the adoption of strategies that depend on the climate, basin characteristics, and socio-economic conditions of the region. IFM is a risk-based approach that utilizes a combination of structural and non-structural approaches. There are six main elements of IFM:

Manage the Water Cycle as a Whole

Integrated Flood Management treats groundwater and surface water as linked resources. An example of this is how floodplains both collect surface water and have retention capacities for groundwater recharge. Interventions that do not consider the water cycle in their planning and implementation can lead to adverse effects. It is also recommended that urban flood plans deal with drinking water supply and wastewater. Without this integrated approach, there is a higher risk for polluted flood waters following flood events. This is difficult to accomplish in urban areas where there is a separation of flood management and stormwater management. At the very least, those who make development decisions must consider the downstream and upstream effects of strategies being proposed.

Integrate Land and Water Management

A significant issue in many regions is that upstream changes in land use can drastically impact a flood. This is because there is an interaction between land and water, as shown in Figure 10.

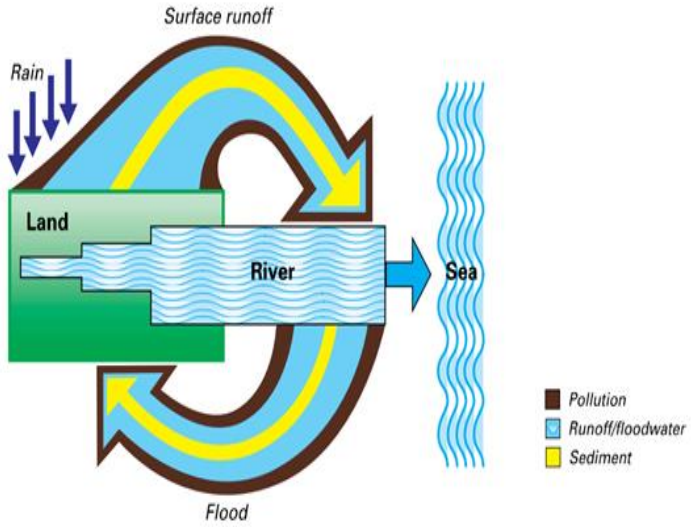


Figure 10: *Interaction between land and water (World Meteorological Organization, 2009).*

For instance, if a pervious natural surface is changed to an artificial impervious one, this can lead to an increase in the rate and volume of stormwater runoff. IFM recommends that land use planning and water management be combined in one plan to enable the sharing of information between land use planning authorities and water management authorities. Such a plan should include maps that display flood hazards and risks. These plans should be based on the entire river basin and consider the main elements of the basin including the

water quantity and quality, as well as processes of erosion and deposition.

Manage Risks and Uncertainty

Integrated Flood Management applies a risk management approach to reduce vulnerability to residents and property in the case of flooding. This approach identifies, assesses, and minimizes or eliminates the risk if deemed unacceptable through policies and practices. Chosen strategies are based on risk assessment which considers the social, economic, and physical setting. These measures include a variety of structural and non-structural approaches.

Adopt a Best Mix of Strategies

The Integrated Flood Management Plan includes strategies that reduce flooding and associated impacts, minimize susceptibility to damage, or preserve the natural resources of floodplains. The selection of one or a combination of strategies requires that the authority look critically at the hydrological and hydraulic characteristics of the water system. Other factors that should be considered when selecting a strategy are the basin characteristics, climate, and socio-economic conditions of the region. It is also important that the strategy does not create new hazards or shift the problem to another location or time period.

Ensure a Participatory Approach

Integrated Flood Management encourages the involvement of the public, planners, and policy makers. The plan should be transparent, communicative, and inclusive. There should be extensive and meaningful public consultation and involvement of stakeholders. It is especially important that stakeholders are sought out so those affected both upstream and downstream are included. It is important that minorities and Indigenous Peoples are represented and heard. Traditional Indigenous knowledge of coping with floods should also inform decision makers when they are evaluating different approaches.

Adopt Integrated Hazard Management Approaches

An integrated hazard management approach considers development concerns, but also integrates emergency planning, prevention, recovery, and mitigation schemes.

3.2 Climate Change and Land Use Planning

Climate change is an issue being faced on all scales across the world. The widest known impacts of climate change on the global scale include changes in temperature, extreme weather conditions, rising sea levels, and increases in severe natural hazard events. One of the major concerns with climate change is the impacts on water resources in relation to flooding as well as droughts and dry spells. All these impacts require

specific and targeted actions for mitigation and adaptation to the changing climactic conditions.

Municipalities, provinces, and countries play important roles in the adaptation to and action against these climate change impacts. Plans to address climate change have been seen on a national scale in Canada with the *Pan-Canadian Framework on Clean Growth and Climate Change*. This plan outlines actions for reducing carbon emissions, innovations and clean technology, building a resilient economy and infrastructure, and placing a price on pollution. This plan was developed with the provinces and territories, and in consultation with Indigenous peoples to ensure Canada is remaining responsive and competitive with meeting global targets of low-carbon emissions (Pan-Canadian Framework on Clean Growth and Climate Change, 2017). Planning tools can be used to address general climate risk in many ways such as:

- Limiting development in hazard zones
- Ensuring resilience of the built environment to environmental stressors
- Preserving natural environments that reduce impacts of hazards within communities
- Education stakeholders, communities, and decision makers about opportunities for climate change adaptation and management

This National framework has been a vital tool in supporting the development and growth of many local level climate change plans and policies to meet the global and national emissions and climate change targets. Although national policy has been an effective lead for evoking conversation about climate change and planning, the role of local government is crucial in evoking changes which can directly address the impacts of climate change (Richardson & Otero, 2012). At the local level, land use planning is one of the most adaptable and well-known tools which can be used to address climate change impacts. Tools such as zoning provisions, official plans, and development reviews are used to minimize risk to communities from the impacts of climate change.

To specifically address planning tools and concepts which can be used to face climate change within communities, the Canadian Institute of Planners developed the *Policy on Climate Change Planning* document in 2018 (Canadian Institute of Planner, 2018). It brings together objectives for the built, natural and rural, and social environments to create tangible goals for Canadian communities and planners to strive for in land use and community planning. Objectives for these environments include items listed in Table 1.

Table 1: *Canadian Institute of Planners Policy on Climate Change Planning Objectives.*

	Climate Change Goals
Built Environment	• Compact, walkable, mixed use urban areas to reduce transportation carbon emissions • Design communities to facilitate efficient distribution of resources and energy with consideration for renewable energy design • Robust strategies to be incorporated into regional and metropolitan plans to include climate change considerations
Natural and Rural Environments	• Communities assess, prioritize, and mitigate risks of natural hazard events • Land use and infrastructure are constantly adapting in areas with physical changes (sea level rise, permafrost thawing, etc.) • Natural areas and their ecological characteristics such as water resources are protected and recognized as vital in adapting to changing climate
Social Environment	• All solutions to climate change support social development and well-being of citizens • Communities become more livable and adaptable for citizens as they adopt to climate change • Local Indigenous knowledge and planning traditions are integrated into the planning process for climate change adaptation

One of the major impacts of climate change is potential increases in river flooding and hazards. Multiple studies have cited issues surrounding the increased frequency and severity of flood events as the greatest impact of climate change. However, a newly arising issue comes from human actions in flood areas as the size of hazard zones expand. The increasing number of people and usable urban and rural areas in growing flood impacted zones is a major concern which must be considered (Arnell & Gosling, 2016). This lens of human decision making and the expansion of hazard areas as a result of climate change will be considered in this report, alongside many other planning tools to address the current issues being faced around the country and within the jurisdiction of Conservation Sudbury. This report will make use of these climate change goals and strategies as one of the benchmark criteria for measuring the success of plans and case studies. The climate change lens will be applied within the Sudbury context to determine the critical impacts of climate change on the City of Greater Sudbury.

3.3 Structural and Non-Structural Approaches to Flood Risk Management

In Ontario during the 1960's and 1970's, flooding was primarily controlled using structural interventions such as river channel engineering, retaining walls, and dams (Toronto and Region Conservation Authority, 2014). These engineered interventions were extremely costly and not a financially viable approach. The development of infrastructure also has impacts up and down stream and in other channels, transferring the flood hazard to other areas. Furthermore, structures can serve as dams during a flood, increasing the flood hazard on surrounding lands (World Meteorological Organization, 2016). Figure 11 displays how engineered structures can have negative flooding impacts up and down stream. Situation A reflects regular water levels whereas situation B illustrates that under flood conditions the bridge acts as a dam, ultimately creating a flood hazard in the upper developed area. Situation C then shows that if the upper developed area were to build embankments for protection, that during the next flood episode, the lower developed area would instead be flooded.

By the 1980's, the Province shifted from the traditional structural engineering approach towards an ecological approach in watershed management (Toronto and Region Conservation Authority, 2014). The shift to an ecological approach does not eliminate the need for structural interventions, however, structural measures no longer need to be hard-engineered solutions (Jha, Bloch and Lamond, 2011, p. 196). Structural measures can be more natural and sustainable such as the restoration of wetlands or preservation of natural buffers (Jha, Bloch and Lamond, 2011, p. 196). Development can incorporate vegetation and

landforms that mitigate flood risks and enable natural processes to continue to function (Queensland Government, 2017). Non-structural measures are also a fundamental component of watershed management. Non-structural measures include increasing preparedness through community communication, flood avoidance through land use planning, emergency planning and management, and increasing overall resilience (Jha, Bloch and Lamond, 2011, p. 288).

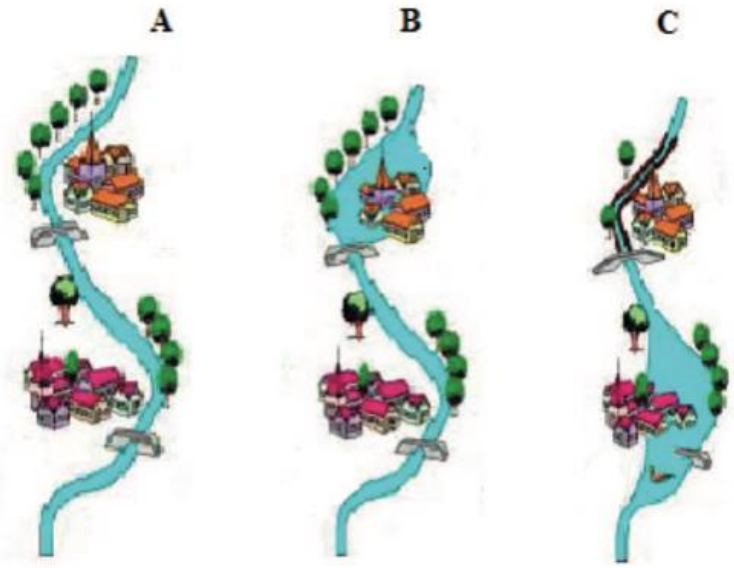


Figure 11: *Visual illustration of engineered structures and the flooding impacts upstream and downstream (World Meteorological Organization, 2016).*

CHAPTER FOUR

EXISTING CONDITIONS

4.0 Existing Conditions

The following section outlines the current conditions present in Sudbury. This relates to the current watershed and floodplain conditions, land uses, and flooding events which have occurred. This section will provide a basis for the analysis and recommendations in the remainder of the report.

4.1 SWOT Analysis

Table 2 details the strengths, weaknesses, opportunities, and threats that Conservation Sudbury could face when proposing a strategy to reduce flood risk. Strengths and weaknesses reflect internal factors that impact the objective and Conservation Sudbury. Opportunities and threats are those influenced by external factors. External factors have been categorized by local community, provincial, and federal government.

Table 2: *SWOT analysis for CS when proposing a strategy to reduce flood risk.*

Internal Factors	**Strengths**	**Weaknesses**
Sudbury Conservation Authority	• CS has a long-standing partnership with the City of Greater Sudbury and the province of Ontario (Conservation Sudbury, 2020) • CS has tools and resources needed to make decisions when a property is within a regulated area. This includes legislative support, mapping tools and regulations staff (Sudbury C., Watershed Management, n.d.)	• Funding and resource constraints limit actions that CS can take to reduce flood risks • Outdated in-house policies guide decision making, but are not reflective of current regulations and legislation • Floodplain mapping was done in the 80's and 90's, but because floodplains are dynamic natural systems, they require mapping that is up to date
External Factors	**Opportunities**	**Threats**
Local Community	• Public may be accepting of a new strategy. The community has been internationally recognized for their regreening program which has rehabilitated Sudbury's landscape and watersheds • Community partners including non-profits, committees, and businesses are currently connecting with and empowering the community to learn about watersheds and conservation	• Public may be unfavourable to adopt a policy that regulates development • While CS has an online interactive map that shows floodplains, it does not cover the entrie City (City of Greater Sudbury, 2019). This prevents the community from making efficient and effective planning decisions • New or intensified development does occur in or adjacent to flood-prone areas in CS's jurisdiction. Other planning interests have been used to justify these decisions • There is a lack of education for the public about the role of CS, creating challenges and violations of regulations and legislation

External Factors	**Opportunities** cont'd…	**Threats** cont'd…
Provincial Government	• Tools and strategies aimed at protecting public health and safety against natural hazards are supported by PPS • Ontario has an established approach and strong flood management policy framework (Government of Ontario, 2020) • The province will encourage the federal government to provide additional funding for flood mapping and other projects that will mitigate flooding. This will be through previously established national funding programs such as the National Disaster Mitigation Program (Government of Ontario, 2020)	• Provincial natural hazard technical guides that CAs use for decision making were created in 1996-2002. Thus, they are outdated and in need of an update (Government of Ontario, 2020) • While provincial policies do not reflect a structural-based approach to flood mitigation, municipalities across Ontario are using structural approaches to solve local land use planning and hazard mitigation issues (Government of Ontario, 2020) • Updated provincial standards for flood mapping are needed if new maps are to be produced (Government of Ontario, 2020)
Federal Government	• The Federal Government has developed the Flood Mapping Guideline Series. These documents are utilized by municipal level authorities to understand and implement Flood Mapping technology (Government of Canada, 2019)	• Many activities related to flood risk mitigation require funding from the federal government (Government of Ontario, 2020). This makes CS reliant on the federal government when wanting to initiate activities related to flood risk mitigation.

4.2 Local Watershed and Floodplain Conditions

Conservation Sudbury is the managing authority over three watersheds which encompass the City of Greater Sudbury and extend into private and government held lands beyond the borders of the City. Within each of the three watersheds there are various waterways and waterbodies in a mixture of lands ranging from an urban city core to rural farmlands. Conservation Sudbury is responsible for the long-term management and regulation of these lands for the health and safety of people and property (Conservation Sudbury, 2020b; Government of Ontario 2020).

4.2.1 Local Watersheds

Within Conservation Sudbury's area of jurisdiction there are three watersheds including the Vermilion River, Wanapitei River, and Whitefish River Watersheds, described in Table 3. Within each of the three watersheds there is a varying degree of urban and rural settlement areas that exist either within the extent of the City of Greater Sudbury or outside the Cities boundaries. Lands outside of the City of Greater Sudbury are generally either Crown Lands which are owned and managed by the Ontario Ministry of Natural Resources and Forestry or privately held properties. (Conservation Sudbury, 2020b; Government of Ontario 2020).

Table 3: *Watersheds Under the Jurisdiction of Conservation Sudbury (Conservation Sudbury, 2020b).*

Watershed	Characteristics
Vermilion River	• Largest watershed under CS jurisdiction • Large areas of rural and undeveloped crown lands or lands under private ownership • Contains majority of built-up urban lands in CGS • Most of industrial mining lands within CGS
Wanapitei River	• Significant undeveloped and rural lands outside CGS jurisdiction • Contains Lake Wanapitei – largest lake within CS lands
Whitefish River	• Smallest area of all three • Half contained in CGS and half in provincial Crown Lands or under private ownership

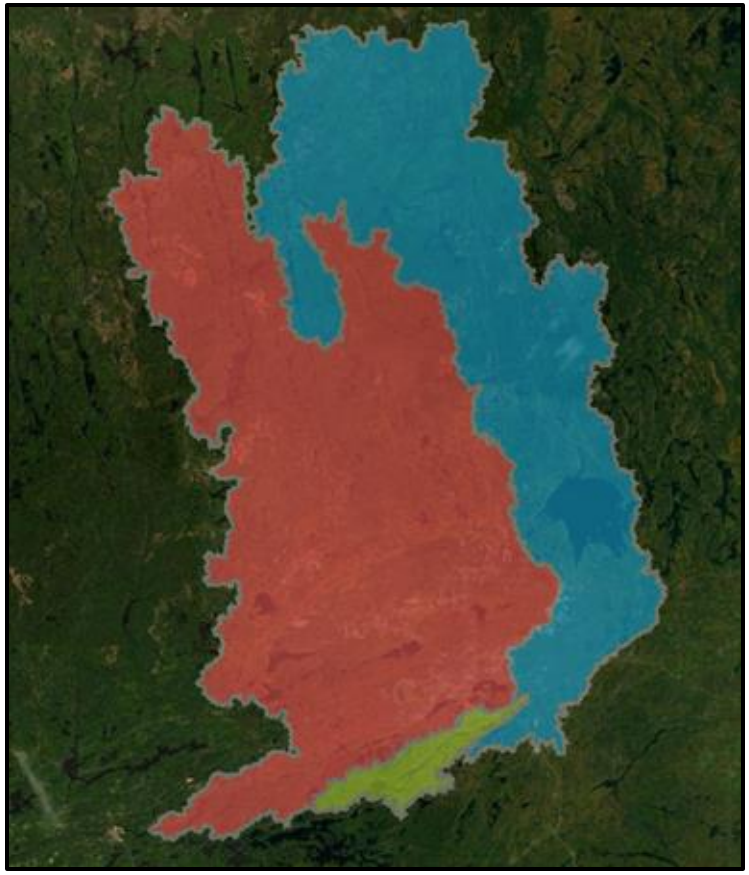


Figure 12: *Geographic boundaries of watersheds under jurisdiction of Conservation Sudbury (Conservation Sudbury, 2020a) (Red - Vermilion River, Blue - Wanapitei River, Green - Whitefish River).*

4.2.2 Zoning Concepts and Floodplain Designation

Within each of the three watersheds, shown in Figure 12, are lands within the regulated floodplains. These lands generally run along the banks of waterbodies and waterways ranging from ponds and lakes, to rivers and streams. The lands are located along lower elevations with a natural susceptibility to flooding events. Within Conservation Sudbury's jurisdiction, floodplains are measured from a storm centered event (1961 Timmins Storm) or the 100-year flood marker, whichever is greater. An example of a floodplain in the City of Greater Sudbury can be seen in Figure 13 below (Nickel District Conservation Authority, 1990b).

Conservation Sudbury's policies and criteria allow for the usage of a one-zone or a two-zone concept when dealing with lands within the floodplain. The one-zone concept exists when the entire area of a specific floodplain is determined to be hazardous as it carries and discharges floodwater during regular or predictable flooding events. The two-zone concept exists when a specific floodplain is divided into the floodway zone and a flood fringe zone. The floodway zone within the two-zone concept is similar to the lands described in the one-zone concept, with the exception of the additional flood fringe. This flood fringe is as an area designated within a specific floodplain which allows for the building and erecting of structures, provided proper approvals and conditions are satisfied (Nickel District Conservation Authority, 1990b).

4.3 Permitted Land Uses Within Floodplain Zones

The lands within the regulated floodplain under the jurisdiction of Conservation Sudbury currently have a series of regulations and criteria to determine what development is allowed in specific areas and zones within floodplains. These regulations are the existing tools Conservation Sudbury uses to control and mitigate risk for buildings and structures constructed within regulated floodplain lands. Maps like the one seen in Figure 14 allow the Conservation Authority to determine what criteria can be applied to specific areas. Lands not within the cross-hatched floodplain but still under the regulation limit are an example of a regulatory buffer. The image shown in Figure 14 is part of the one-zone concept (Nickel District Conservation Authority, 1990a).

Some of these tools and policies of Conservation Sudbury do not necessarily reflect current best practices. Therefore, one of the overall goals of this report is to provide baseline research and guidance which will inform updates and improvements to these existing policies. Current land uses and floodplain definitions used by Conservation Sudbury will be listed and defined throughout the remainder of Section 4.3.

Figure 13: *Shows the regulated area of the floodplain, floodplain buffer, Ponderosa PSW, and Junction Creek amalgamated as one regulatory layer (Conservation Sudbury, 2020a).*

Figure 14: *Screenshot from Conservation Sudbury internal GIS mapping outlining floodplains, wetlands, and waterbodies. This image is taken of the Flour Mill neighbourhood in Sudbury.*

4.3.1 The Floodway

The floodway or floodway zone as described in Section 2 of Conservation Sudbury's Floodplain Management Criteria is the area of land which is regulated by conservation Sudbury as it is most at risk of flooding. It requires special planning approvals from Conservation Sudbury to build on lands within the floodway. Uses allowed in the floodway are heavily restricted and have been carefully determined by Conservation Sudbury as being permitted provided various building criteria and conditions are filled. Uses are to pose a minimal risk to obstructing flood flows and generally not consist of structures, fill, or storage of materials or equipment. Land uses allowed within the floodway shall not adversely affect water flows. A common theme among uses allowed in the floodway is that they all have limited, or no structures allowed on them. This is because the floodway can be dangerous to both people and property due to predictable or regular flooding events. It is important to limit structures allowed within the floodway zone as these lands are an important part of the watershed's drainage process and help to mitigate the effect of floods and flooding events (Nickel District Conservation Authority, 1990a).

The floodway has limited primary uses ranging from certain types of agricultural, industrial and commercial uses. These uses are outlined within Table 4 with a more expansive list which can be found within *The Nickel District Conservation Authorities Flood Plain Management Criteria* (Nickel District Conservation Authority, 1990a).

When building within the floodway permits need to be obtained through Conservation Sudbury to allow for special uses which may contain built structures on them. The special uses permitted by Conservation Sudbury allow for other varying uses on a case-by-case basis, provided they are within similar nature to the permitted and special uses described in Table 4 (Nickel District Conservation Authority, 1990a).

Table 4: *Allowed Land Uses within a Floodway Zone.*

Primary Land Uses	
Agricultural Land Uses	general farming areas, pastures, and plant nurseries
Industrial and Commercial Uses	loading areas and parking lots
Recreational and Residential Uses	residential lawns, gardens, parking, golf courses, parks, nature preserves, and conservational lands
Special Uses Through Conservation Sudbury Permitting	
Entertainment	Circuses and drive-in theatres
Industrial	mineral extraction and storage yards
Commercial	marinas, and transportation networks including railroads, streets, bridges, etc.

4.3.2 Flood Fringe

Flood fringe or flood fringe zone as described in Section 3 of Conservation Sudbury's *Floodplain Management Criteria,* are unique areas within the floodplain which allow for the same permitted uses as the floodway while also allowing for buildings and structures provided certain criteria are met and approved by Conservation Sudbury. Within the flood fringe, structures must have all openings, floors, and habitable ground 0.3m above the regulatory flood protection elevation. All fill shall be no lower than the regulatory flood protection elevation and for at least 15 feet (4.5 metres) beyond the limits of any structure or building (Nickel District Conservation Authority, 1990a).

Additionally, no fill placed within the flood fringe shall adversely impact the capacity of the floodplain or channels to mitigate flood protection and drainage. Conservation Sudbury also retains the ability to approve projects and structures within the flood fringe provided a satisfactory flood-proofing technique can be demonstrated. Otherwise, structures shall always be elevated by 0.3m as stated above (Nickel District Conservation Authority, 1990a).

4.3.3 Floodplain

Floodplain or floodplain zones, as described in Section 5 of Conservation Sudbury's *Floodplain Management Criteria*, have the same restrictions and uses as lands designated as floodways. Properties which lie within regulated floodplain lands may acquire permits from Conservation Sudbury which will then determine whether floodway or flood fringe restrictions and exemptions apply. Floodplain designations are used in the one-zone concept which makes up the majority of hazard lands within the Conservation Sudbury jurisdiction (Nickel District Conservation Authority, 1990a).

4.3.4 Nonconforming Uses

The two types of nonconforming uses, legal nonconforming uses and nonconforming uses. A nonconforming use exists when a structure does not conform with the current policies outlined within the Conservation Sudbury's Flood Plain Management Criteria and associated policy. A 'legal' nonconforming use must have been built or erected prior to the introduction of current policies. This makes the structure 'legal' as it existed at a time when there were no policies restricting its current state. It is 'nonconforming' as it does not conform or fall into an allowed use of the current policy.

Nonconforming uses are those which are in direct violation of a policy which is in place at the time of erection. A nonconforming structure or use can be something as simple as a building being constructed below the regulatory floodline, or a building which is not permitted under the current policies.

All nonconforming uses are generally not permitted by Conservation Sudbury to be expanded, changed, enlarged, or

altered in any way which increases a building or structures nonconformity, unless given exception by Conservation Sudbury. In the event that a building or structure is destroyed by any means to an extent of 50% or more of the structures 'fair market value', its rebuild and reconstruction shall conform within the policies and criteria set out by Conservation Sudbury (Nickel District Conservation Authority, 1990a).

There are several ways a landowner can convert a structure to a conforming use from a nonconforming use within a floodplain. The most straightforward way is to install and build floodproofing measures for a building or structure to make it more resilient to flooding and flood hazards. Another option is to move a building away from flood hazard lands. In situations where the moving of a structure off regulated lands is impossible or may conflict with zoning within the City of Greater Sudbury, landowners can apply for special permits through Conservation Sudbury. This permit allows protection techniques to be implemented to prevent risk and potential damage from being within floodplain zoned lands (Nickel District Conservation Authority, 1990a).

4.3.5 Flood Hazard Provisions within the City of Greater Sudbury's Zoning By-Law

The City of Greater Sudbury has a section within its Zoning By-Law outlining the city's provisions and standards when it comes to land uses within floodplains. The City of Greater Sudbury uses a two-zone concept as outlined by Conservation Sudbury, as the City has policies in place for buildings and structures built or proposing to be built on the flood fringe and the floodplain (City of Greater Sudbury, 2010).

Within flood fringe overlay zoned lands of the City of Greater Sudbury's Zoning By-Law, new buildings, structures, and additions are permitted in accordance with their underlying zoning. All new buildings and structures built within the flood fringe shall be elevated 0.3m above the elevation of the regulatory floodplain and no bedrooms shall be permitted below the land designated under the regulatory floodplain. Lands zoned as floodplain overlay within the City of Greater Sudbury's Zoning By-Law allow only for legally existing buildings and structures to be permitted within floodplain lands. Structures which are legally existing are structures or buildings which were built legally with permits and planning approval and could have existed prior to being designated with the boundary and area of a floodplain (City of Greater Sudbury, 2010).

The *Conservation Authorities Act* outlines that development within land zoned as flood fringe overlay are subject to approval by the relevant Conservation Authority. This land is referenced as floodplain overlay in the City of Greater Sudbury Zoning By-Law and is equivalent to what Conservation Sudbury refers to as floodplain lands. This approval is subject

to requirements set out by the Conservation Authority as they shall be consulted on development within the floodplains (City of Greater Sudbury, 2010).

4.4 Recent Flooding Events in the Greater Sudbury Area

The City of Greater Sudbury contains many known hazard areas that can experience annual and/or seasonal flooding. Types of flooding that occur within the region include snow and ice melt runoff floods, spring rainfall, severe summer storms, ice jams/frazil ice, debris jams, dam break or breach, water main break, and urban flooding. Snowmelt runoff floods are the most common type of flooding in the City, and result from rapid springtime snow melting and large quantities of water being released (Greater Sudbury, 2019). In this section, three flooding events are discussed to exemplify the variety of flood causes in Greater Sudbury.

4.4.1 Snowmelt Runoff in the Flour Mill

Many properties in the Flour Mill neighbourhood just north of downtown Sudbury, are built in the Junction Creek floodplain as shown in Figure 13 and Figure 14. There is some degree of flooding in this neighbourhood every year, and residents are at risk of basement flooding and other property damage (White, Flooding swamps New Sudbury roads, homes, 2014). This flooding has also caused destruction to public property, traffic disruption, and difficulty in attaining and delivering emergency services. Figure 15 was taken after a flooding event on Notre Dame Avenue on April 15th, 2014. Freezing overnight temperatures turned flood waters into slush and ice along parts of the road, which lead to the closure of some parts of Notre Dame Avenue.

Figure 15: *Van driving through slush and ice flood areas on Notre Dame Avenue in Sudbury on April 15th, 2014 (White, Flooding swamps New Sudbury roads, homes, 2014).*

4.4.2 Flash Flooding in Capreol

In July 2020, heavy downpour rain in Capreol resulted in flooding around the Dennie Street and Ormsby Avenue area, as can be seen in Figure 16. These two roads were closed to traffic and there were 17 reports of flooded basements and streets in the area. Residents have since reported to the media that this is a regular occurrence when there is heavy

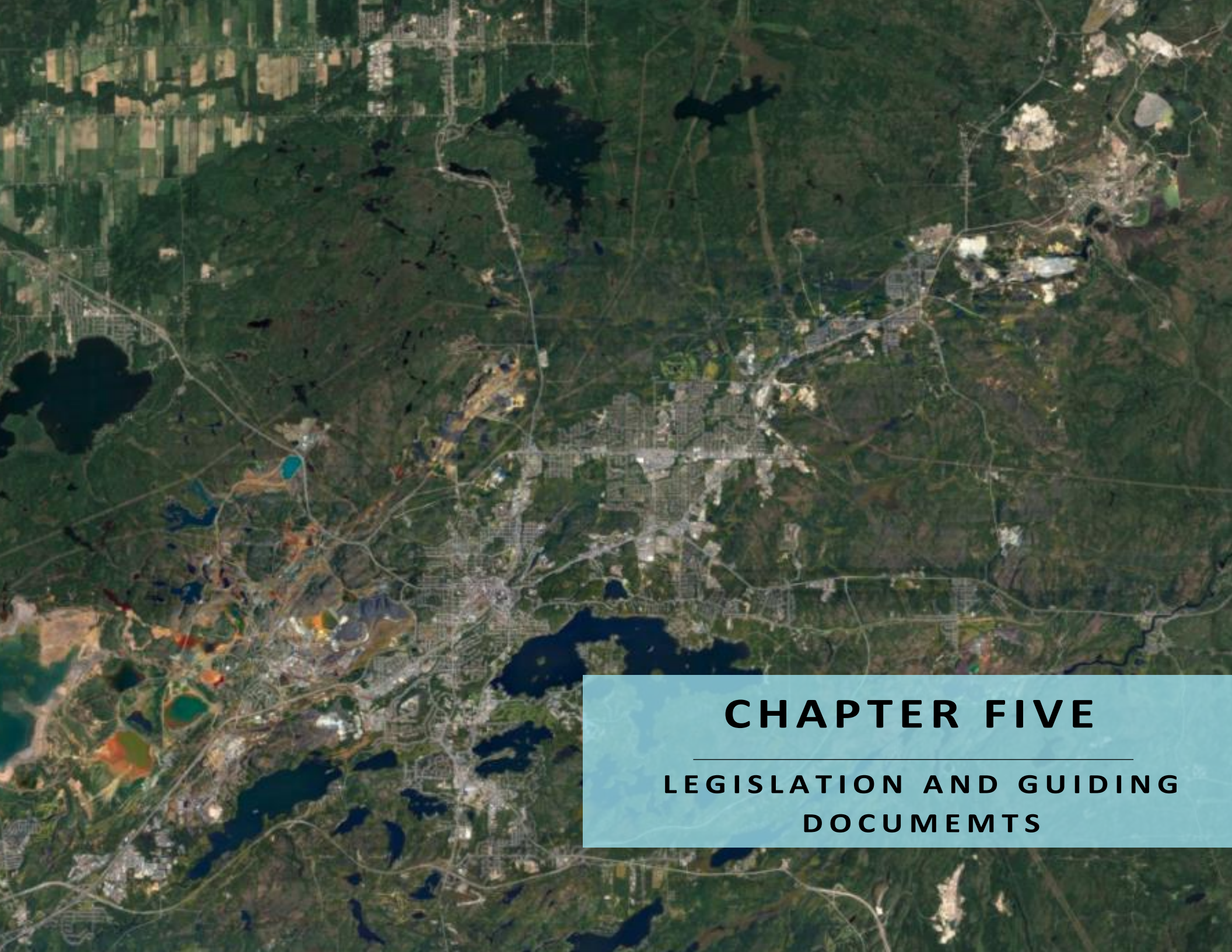
rainfall, and claim that the drainage system cannot handle this type of rain (Sudbury Star Staff, 2020). Residents living in the Lakeshore Street area of Capreol are especially vulnerable to water and sewer backups in their basements as this area is built in the Vermilion River floodplain.

4.4.3 Urban Flooding in the Flour Mill

Many residents that live on Mountain Street in the Flour Mill neighbourhood have reported increased water running down the hill behind the street since 2009. An image of this is shown in Figure 17. This runoff has caused basement flooding when it rains heavily, and constant water running into their backyards (White, 2017). While this area is adjacent to the Junction Creek Floodplain, the residents maintain that the cause of flooding is a recent subdivision built on top of the hill. In 2015, Sudbury city council committed to $4 million to flood proof the area which included the building of a drainage ditch (White, 2017).

Figure 16: *Flooding on Dennie Street at Ormsby Avenue in Capreol on July 7th, 2020 (Sudbury Star Staff, 2020).*

Figure 17: *Water falling to Mountain and Leslie Street area after heavy rain in 2010 (Dillman, 2011).*



CHAPTER FIVE

LEGISLATION AND GUIDING DOCUMEMTS

5.0 Legislation and Guiding Documents

The following section outlines the legislation and guiding documentation which aided in the research, analysis, and composition of this report. Legislation from municipal and provincial documents such as the *Official Plan of Greater Sudbury* and *Ontario Provincial Policy Statement* were reviewed and utilized to guide the final recommendations. The national and international guiding documents included items which provide general guidance and advice for smaller scale land use planning tools to address flood risk management. This section ensures that all relevant policy and regulations are considered and met through the final recommendations, and that compliance to municipal and provincial jurisdiction is followed.

5.1 Flood Risk Management: Who Does What?

Table 5 below contains a summary of the provincial and municipal authorities involved in flood management in Ontario, their respective responsibilities, as well as the enabling policies that delegate these responsibilities. Each of these authorities and the specific responsibilities they carry out will be discussed in the remainder of this section.

Table 5: *Flood Risk Management Responsibilities.*

Authority	Responsibilities	Relevant Policy Documents
Ministry of Natural Resources and Forests	• Conduct flood mapping and studies. • Produce technical guidelines to guide implementation of provincial flood hazard policies. • Advise municipalities on content and application of provincial natural hazards policies defined in the *Provincial Policy Statement*.	• *Lakes and Rivers Improvement Act* • *Public Lands Act* • River and Stream Systems: Flood Hazard Limit (technical guide)
Ministry of Municipal Affairs and Housing	• Ensure that municipal planning documents have regard for natural hazards policies. • Administer the *Provincial Policy Statement*.	• *Provincial Policy Statement* • *Ontario Building Code*
Conservation Sudbury	• Conduct flood mapping and studies. • Provide existing mapping, data and technical assistance to government bodies and planning authorities. • Comment on proposed planning actions that have implications for water-related hazards (such as flooding and erosion). • Consult with government agencies and authorities on the management of lands susceptible to water-related hazards. • Inform the public on the principles of water-related hazards, as well as the consequences of these hazards for lands on shorelines or in floodplains. • Represent the Province in matters of Provincial interest in planning matters.	• *Conservation Authorities Act* • *Ontario Regulation 156/06* • *Planning Act* • *Clean Water Act*
City of Greater Sudbury	• Implement natural hazards policies through planning controls (such as zoning by-laws, plan of subdivision and land severance, and site plan control) as specified in the *Official Plan*.	• *Planning Act* • *Official Plan* • Zoning By-Laws • Plan of Subdivision and Land Severance • Site Plan Control

5.2 Provincial

Provincial governments play an important leadership role in aligning land use planning to help reduce flood risks. Provinces do this by defining the watershed scale and establishing land use planning tools. The top-down guidance provided by provinces can help coordinate cooperative strategies that unify jurisdictions and administrations within watersheds. The Province of Ontario has a well-established approach to managing flood risk. This approach requires a coordinated effort by many government agencies to protect the public from the effects of flooding. Figure 18 outlines this four-stage process.

The first two stages of this approach contain actions that are undertaken before flood events occur to minimize the harmful effects of flooding on people and property. The second two stages consist of actions that are undertaken after flood events to help communities quickly respond and recover. Land use planning authorities are primarily concerned with the first two stages of this model.

The responsibilities associated with the flood risk management activities in these stages are administered by four main authorities:

- The Ministry of Natural Resources and Forestry
- The Ministry of Municipal Affairs and Housing
- Conservation Authorities
- Municipalities

Each of these authorities have unique responsibilities for managing flood risk which are clearly articulated in governing legislation and policy documents. The following sections will

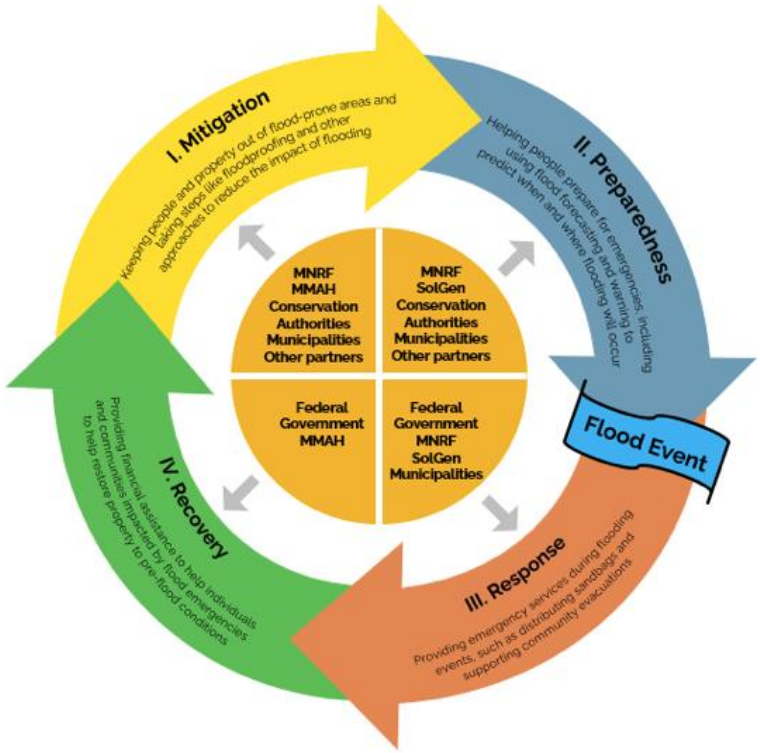


Figure 18: *Province of Ontario Flood Risk Management Approach.*

explain the policy context for each of these authorities to provide an overview of the existing approaches to flood risk management.

5.2.1 Ministry of Natural Resources and Forestry (MNRF)

The Ministry of Natural Resources and Forestry (MNRF) is the lead agency for developing natural hazard policies, including flooding and flood hazard policies. These policies require municipalities to identify areas prone to natural hazards so that new development considers the potential threat of flooding to public safety. To support municipalities and other planning authorities in the implementation of these provincial policies, the MNRF has produced a series of natural hazard technical guidelines. These guidelines set minimum standards for assessing and mapping floodplains. In parts of Ontario where no conservation authority exists, the MNRF provides technical support to the Ministry of Municipal Affairs and Housing (MMAH) on matters related to natural hazards. The MNRF also has legislative authority over dams in Ontario under the *Lakes and Rivers Improvement Act*. Although dams can affect flood events, they do not play a significant role in Ontario's preventative approach to managing flood risk through land use planning.

5.2.2 Ministry of Municipal Affairs and Housing

The Ministry of Municipal Affairs and Housing (MMAH) is the lead agency for land use planning in Ontario. It is responsible for administering the *Provincial Policy Statement (PPS)*, which is a statement of the Province's policy objectives under the *Planning Act*. This is the primary document which planning authorities refer to when making land use planning decisions. Section 3.1 of the PPS identifies land use policies to protect the public from natural hazards. Planning authorities refer to this section of the PPS when outlining the impacts of flooding or to restrict or direct development. A recently updated PPS came into effect May 1, 2020 and introduced several changes. The most significant change to natural hazards policies was section 3.1.3. This section previously stated that "planning authorities shall consider the potential impacts of climate change that may increase the risk associated with natural hazards" (Government of Ontario, 2014). It has now been altered to state that "planning authorities shall prepare for the impacts of a changing climate that may increase the risk associated with natural hazards" (Government of Ontario, 2020).

With respect to flood hazards, this means that planning authorities are already required to recognize that climate change can cause more frequent and unpredictable extreme weather events leading to more severe and frequent flood events. Furthermore, planning authorities are now required to make land use decisions that prepare for these consequences. This means that planning authorities must adjust land use

decisions to better protect the public from more severe and frequent flood events.

5.2.3 Conservation Authorities

Conservation authorities are local charitable or non-profit watershed management agencies legislated under the *Conservation Authorities Act*, 1946. The primary responsibility of conservation authorities is to undertake watershed-based programs to protect people and property from flooding and other natural hazards, and to conserve watershed-based natural resources for economic, social, and environmental benefits. CAs have been delegated natural hazard responsibilities by the MNRF, through a Memorandum of Understanding between the MNRF, the MMAH and Conservation Ontario.

In fulfillment of these delegated responsibilities, CAs are responsible for representing the provincial interest on natural hazard planning matters where the Province is not involved. Conservation authorities do this through their authority under section 28 of the *Conservation Authorities Act*, by reviewing policy documents and development proposals processed under the *Planning Act* to ensure appropriate compliance with section 3.1 of the PPS. It is important to note that while the Planning Act does enable land use controls to address flooding, Conservation Authorities get their powers of approval from the *Conservation Authorities Act* and not the *Planning Act*. Under the *Planning Act* conservation authorities are considered a public body that the city is required to consult regarding planning approvals within the regulated floodplain. Although a development may have received approval from the planning authority, if the proposal cannot demonstrate compliance with CA regulations the development will not receive a permit and therefore not proceed.

Each conservation authority currently administers an individual Development and Interference regulation under Section 28 (1) of the *Conservation Authorities Act*: *Development, Interference with Wetlands and Alterations to Shorelines and Watercourses.* Conservation Sudbury currently administers Regulation 156/06 under this section, which lists specific prohibitions and permissions for development within its jurisdiction.

CAs are required to geographically describe the hazardous lands and areas susceptible to flooding based on applicable flood standards set by the MNRF technical guidelines (i.e. Hurricane Hazel, the Timmins event, the 100 year, etc.). This hazard mapping provides support for implementing the CA regulations under the *Conservation Authorities Act* and for the conservation authority's commenting role on Official Plan review activities delegated under the *Planning Act*.

5.3 Municipal

5.3.1 Official Plan

The City of Greater Sudbury outlines two important visions related to flood management within its *Official Plan*. The City aims to be resilient to climate change through informed planning around flood hazards. The City also states the public health and safety of Greater Sudburians is protected from natural and human made hazards through direction of new development outside of flood hazard areas. (City of Greater Sudbury, 2019).

The following sections outline in greater detail the sections of the *Official Plan* which are relevant to flood risk management and protection.

Stormwater

Section 8.5 demonstrates the City's understanding that stormwater is a significant problem by stating that if left unchecked it can lead to increased risk of flooding. Additionally, this section notes the importance of managing stormwater due to increased urbanization. Urbanization often includes increased coverage of impervious surfaces which increases runoff and consequent flooding. The imminent threat of climate change, which has the potential to change seasonal precipitation and extreme weather events, can also increase the capacity required by stormwater systems (City of Greater Sudbury, 2019).

Subwatershed Plans

The creation of Subwatershed Plans noted in Section 8.5.2 is to ensure proper stormwater management practices are undertaken. This is to ensure the sustainability and enhancement of urban subwatersheds and their interaction with urban lakes and watercourses. These plans are at the subwatershed scale to provide a coordinated strategy for stormwater management for all development within individual watersheds. Currently, there has only been subwatershed research for 2 of 17 subwatersheds in the City of Greater Sudbury jurisdiction, including Ramsey Lake and Junction Creek (City of Greater Sudbury, 2019).

Flooding and Erosion Hazards

Section 10.2 of the *Official Plan* notes the hazards of flooding and erosion. Flooding hazards occur where lands adjacent to shorelines, lakes, rivers, or streams that are not normally covered by water become flooded due to rainfall, wind and other factors. This section the *Official Plan* notes that Conservation Sudbury is responsible for regulating development and site alteration on lands adjacent to the shoreline of lakes, rivers and streams impacted by flooding or erosion hazards across most of the area of Greater Sudbury. The MNRF is responsible for the areas not within the

jurisdiction of Conservation Sudbury. The City of Greater Sudbury has five policies associated with flooding and erosion hazards. The following policies are applicable to lands designated as 'Hazard Lands' (City of Greater Sudbury, 2019).

1. Since flooding can cause loss of life and damage of property, development on lands adjacent to the shoreline of a watercourse or waterbody affected by flooding or erosion are generally restricted but may be approved by Conservation Sudbury or MNRF.
2. Notwithstanding the above, there is to be no development or site alteration of lands within a floodway, even if a portion of a property exists outside the floodway.
3. Additionally, there is to be no development or site alteration if it leaves the site inaccessible to people and vehicles during times of hazard, unless it can be demonstrated that the site has safe access appropriate to the nature of the development and hazard.
4. Institutional uses such as hospitals, long-term care facilities, retirement homes, pre-schools, elementary schools, and secondary schools as well as essential emergency services and industrial uses involving the disposal, manufacturing, treatment, or storage of hazardous substances are not permitted on lands subject to flooding or erosion hazards.
5. Uses that must locate within a floodplain, including flood or erosion control, minor additions, and passive non-structural uses that do not impede flood flows, are permitted.
6. Any alteration to the terrain within a floodplain which may affect drainage and the erection of any structure must first receive the approval of Conservation Sudbury or the MNRF.

Existing Structures in the Floodplain

Section 10.2.1 Existing Structures in the Floodplain, notes how the City is dealing with existing structures in a floodplain. Buildings existing within a floodplain at the time of the *Official Plan (*May 2019) may be recognized as permitted uses in the implementing zoning By-Law. The improvement, expansion, alteration, and replacement of existing structures within a floodplain may be allowed by a site-specific amendment, providing that existing hazards are not aggravated, and flood protection measures receive the approval of Conservation Sudbury or the MNRF (City of Greater Sudbury, 2019).

Community Improvement

Section 15.2 Identification notes that community improvement project areas with flood-susceptible or natural drainage characteristics that require floodproofing also require stormwater management actions to be taken to

alleviate storm-related flooding situations in the area (City of Greater Sudbury, 2019).

Waterfront Development

Section 20.6.2 Waterfront Development states the rezoning of seasonal dwellings into permanent dwellings is permitted if new or replacement field beds are set-back a minimum of 30 metres from the high-water marks. All new main accessory buildings, except boathouses, are set back a minimum of 25 metres. All new waterfront lots from plans of subdivision, consent, or existing lands are not permitted if constrained by environmental hazards including steep slopes, swamps, or if it lies within a designated floodplain (City of Greater Sudbury, 2019).

Additional Hazard Land Policies

While development is generally restricted on lands subject to flooding and erosion hazards, there are areas in the communities of Sudbury, Dowling, Azilda, and Chelmsford which have additional policies. These areas are Hazard Lands and not "Special Policy Areas" as identified in the *Provincial Policy Statement*. Development in these areas is subject to the approval of Conservation Sudbury or the MNRF and will not be permitted if there is an unacceptable risk to public health and safety or property damage. The policies for these areas are contained within the table seen in Appendix 3: Designated Hazard Lands and Policies Within the City of Greater Sudbury (City of Greater Sudbury, 2010). The general areas which are impacted by these policies include the following:

- The Communities of Sudbury
    - Alexander Street
    - Notre Dame Avenue
    - Flour Mill
    - Long Lake Road Bypass
    - Ponderosa Area
- The Community of Dowling
    - Flood Fringe
- The Community of Azilda
    - Floodway
    - Flood Fringe
- The Community of Chelmsford

5.3.2 Junction Creek Subwatershed Study and Stormwater Master Plan

Wood Environment and Infrastructure Solutions (2019) prepared The Junction Creek Subwatershed Study and Master Plan for the City of Greater Sudbury, as outlined in section 8.5.2 of the City of Greater Sudbury's *Official Plan*. The purpose of this section is to note the New Development recommendations related to flooding (Wood Environment and Infrastructure Solutions, 2019).

The first recommendation that comes out of this report is related to mitigation of climate change impacts with regard to flooding. All new stormwater management facilities are to target a release of 85% of pre-development rates for the 100-year storm. This means any site that contains a new stormwater management facility must allow 85% of the sites water flows to continue after the site is developed. Given the flooding within the Junction Creek upstream of the existing Box Culvert and projections that precipitation may increase 250% due to climate change, this report notes that consideration must be given to new development policies to improve upon the existing situation (Wood, 2019). The second recommendation the report notes is that a risk-based approach be established for new greenfield development and key infrastructure within the Junction Creek Watershed.

5.3.3 Ramsey Subwatershed Study and Master Plan (Phase 2 Report)

Aquafor Beech Limited (2020) prepared the Ramsey Lake Subwatershed Study and Master Plan for the City of Greater Sudbury, as outlined in section 8.5.2 of the *City of Greater Sudbury's Official Plan* (Aquafor Beech Limited, 2020). The purpose of this section is to note the report findings on flood mitigation in existing urbanized areas.

Aquafor Beech Limited (2020) notes there are 15 buildings within the regional floodplain. The former Canoe Club located in Bell Park is noted to frequently flood during the spring. Additionally, this report noted 5 flood risk areas within the Ramsey Creek subwatershed which were identified as areas with buildings in the floodplain, spills, or backwatering. The report goes on to note engineering flood mitigation alternatives, but no land use flood mitigation strategies were provided.

5.4 National

5.4.1 The National Disaster Mitigation Program (NDMP)

In 2015, the Government of Canada established the National Disaster Mitigation Program (NDMP) to provide knowledge about flood risks and investments. This knowledge was aimed to reduce the effects of flood events in Canadian communities (Government of Canada, 2019). The intent of the program was to provide current and relevant information to help governments, communities, and individuals understand what flood risks are and employ effective mitigation strategies. The NDMP has established a funding stream for provincial and territorial governments to provide monetary funding for flood risk management strategies and projects which can be allocated to the local level based on provincial and federal discretion. The four streams of funding include risk assessments, flood mapping,

mitigation planning, and investment in non-structural and small structural mitigation projects. This program was implemented as a method of education and funding for communities and provinces to address issues of flood risk management and flooding events.

5.4.2 Federal Flood Mapping Guidelines Series

The Government of Canada also developed multiple documents in the Federal Flood Mapping Guidelines Series (Government of Canada, 2019). This series aims to assist with the advancement of flood mapping activities across Canada as an effective tool for flood risk management and mitigation. They are specifically targeted at addressing overland flooding as the most hazardous type of flooding in Canada through strengthening of flood mapping services and programs across the country. Documents in this series include:

- Federal Flood Mapping Framework
- Federal Airborne LiDAR Data Acquisition Guideline
- Bibliography of Best Practices and References for Flood Mitigation
- Case Studies on Climate Change in Floodplain Mapping
- Federal Hydrologic and Hydraulic Procedures for Flood Hazard Delineation
- Federal Geomatics Guidelines for Flood Mapping

These documents are utilized by provincial and municipal level authorities across Canada to further understand and implement flood mapping technology and practices on the local and provincial scale.

5.5 International

The United Nations Office for Disaster Risk Reduction (UNDRR) published the *International Guidelines for Reducing Flood Losses* in 2002 as contribution to part of a larger *International Strategy for Disaster Reduction (United Nations Office for Disaster Risk Reduction, 2002).* Partners from within the United Nations and worldwide organizations worked alongside the United Nations system to develop a wholistic document for flood risk mitigation and reduction.

The goal of this document was to provide guidelines for decision-makers and communities around the world, to develop and further understand mitigation options that can be used to reduce losses from flooding. The use of these tools and guidelines was intended as a first step for communities and political decision makers worldwide who were unaware of the current methods used to approach new and non-structural based flood prevention tools. The guidelines emphasize the need to adopt a more wholistic and preventative approach to flooding on a global scale, as opposed to the previous post-disaster response model. The guidelines provide background knowledge on the social and economic considerations which

must be made in disaster reduction and responses. They also outline response strategies and public awareness methods that can be utilized to reduce the economic and social impacts of flooding. Following this, a list of the major elements and strategies for flood disaster management are outlined and explained in an international context, as seen below.

- Floodplain delineation
- Technological solutions and support
- Floodplain and watershed management
- The impacts of climate change and variability
- Methods to develop policies, strategies, and plans for flood loss reduction
- The use and importance of integrated flood forecasting, warning, and response systems

This document served as a base of knowledge for the initial adoption of preventative and mitigative approaches to flood disaster and risk management. This document has not been altered or updated with changes to technology, information, global climate change, and guidance for best practices and flood risk management techniques. More robust structures and planning tools have been developed to guide and address flood risk management, however this is an important document to showcase the initial intent and progress which has been made in relation to flood risk management practices.

CHAPTER SIX

CASE STUDIES

6.0 Case Studies

6.1 Purpose

A series of case studies were examined to determine the best practices and flood risk management policies which have been successfully implemented in other jurisdictions. These case studies informed useful and relevant policy and land use planning methods which may be of use to Conservation Sudbury. The cases were selected from across Ontario and Canada, with one one example from the United States. The successful methods and policies found in these case studies were then utilized to formulate a list of final recommendations which are intended to inform future land use policy development by Conservation Sudbury. Geographic area, climate conditions, and political structure and governance were considered in order to select the most appropriate case studies for the context of Conservation Sudbury.

6.2 Summary of Case Studies

The methods of evaluation, specific case study analysis, and final recommendations are detailed in the latter sections of this report.

In addition to Conservation Sudbury the following 21 case studies were examined:

- Lakehead Region Conservation Authority
- Mattagami Region Conservation Authority
- North Bay-Mattawa Conservation Authority
- Sault St. Marie Region Conservation Authority
- Kawartha Conservation
- Otonabee Region Conservation Authority
- Nottawasaga Valley Conservation Authority
- Lake Simcoe Region Conservation Authority
- Ganaraska Region Conservation Authority
- Rideau Valley Conservation Authority
- South Nation Conservation
- Mississippi Valley Conservation Authority
- Cataraqui Region Conservation Authority
- Essex Region Conservation Authority
- Grand River Conservation Authority
- Long Point Region Conservation Authority
- Maitland Valley Conservation Authority
- Saugeen Valley Conservation Authority
- Upper Thames River Conservation Authority
- City of Prince George
- New York State Southern Tier Central Region

6.3 Methodology

6.3.1 Case Study Selection

Case studies were selected from locations which were researched and found to be significant in relation to policy and programs surrounding flood risk management. Consideration of geographic area, climate conditions, and political structure and governance were used to first select a list of case studies. This included all conservation authorities in Ontario, several governing bodies in Canada, and a small number of authorities and bodies outside of Canada. To further evaluate the applicability of the case studies and narrow down the list of appropriate studies, an evaluation tool for context similarity was created. Context similarity was been divided into two subcategories: geographic location and urban characteristics. These subcategories contain five additional assessment criteria, as outlined in Table 6. Each criterion is assigned a maximum number of points. The case studies were evaluated according to these criteria and once complete, the assigned points for each category were divided by the maximum points possible. This fraction was then indexed to a score out of ten. Only case studies with a minimum score of 5/10 for context similarity were evaluated.

Geographic Location

Three geographic location criteria were evaluated: case study jurisdiction, costal relationship, and climatic zone. Geographic locations similar to Conservation Sudbury were determined to be more relevant as these case studies would share similar socio-economic backgrounds, policy environments and flood risk characteristics. A major consideration in this regard is the location of the case study. Cases drawn from Northern Ontario were deemed most relevant, followed by case studies in other parts of Ontario, then those in Canada, and finally cases located in other countries. To control for the possibility that case studies in a different countries or provinces could still contain excellent practices, the researchers also examined whether the location was coastal or inland and if it has a similar Köppen Climate Classification. The Köppen Climate Classification system defines areas around the world by their average temperature and precipitation and natural vegetation. This filters for similar geographic contexts in other parts of the world (Arnfield, 2020).

Urban Characteristics

Two urban characteristics criteria were evaluated: population density, and population size. The total population and population density were examined as indicators of the financial capacity of the flood risk management authority. Although there will not be a perfect correlation between population and funding, this appeared to be the best metric to evaluate funding across jurisdictions that have different funding sources, responsibilities, and goals. Additionally, the

cost of actions that are necessary to mitigate flood risk, rise proportionally with population size and density. For example, the Toronto Region Conservation Authority may be able to adopt extensive projects and policies, however, they have a large population and high population density to fund those actions. Therefore, it would not be appropriate to compare Conservation Sudbury to the Toronto Region Conservation Authority.

More points were awarded to case studies from locations with smaller populations and lower population densities than Conservation Sudbury than to those from locations with larger populations and higher population densities. The rationale for this is that if a smaller and less densely populous location could adopt best practices, then this would be a strong indication that Conservation Sudbury could also adopt these practices. To the contrary, if a slightly larger and more populous location also adopted best practices, it would not necessarily follow that Conservation Sudbury could replicate these practices.

Table 6: *Context similarity evaluation matrix.*

Category	Sub-Category	Criteria	Max points
Context Similarity	Geographic Location	(0) International (1) National (2) Provincial (3) Northern Ontario	(3)
		(0) Costal (2) Inland	(2)
		(0) Different Koppen Climate Classification (2) Same Koppen Climate Classification	(2)
	Urban Characteristics	Population Density (persons/sqkm) (1) 0-4 (2) 5-24 (3) 25-99 (2) 100-999 (0) 1000+	(3)
		Population (1) 0-9,999 (2) 10,000-99,999 (3) 100,000-249,999 (2) 250,000-499,999 (0) 500,000+	(3)

6.3.2 Case Study Evaluation

After case studies were selected and their context similarity was assessed, each flood management authority was evaluated using a rubric consisting of four major categories. Each of these categories is divided into sub-categories, each of which contains specific evaluation criteria. Major categories and sub-categories are displayed in Figure 19. Each criterion is weighted from 1 to 4. Allocation of points on this scale was determined by two factors. First, criteria which was associated with only policy and policy changes were eligible for 1-2 points, whereas criteria which produced and enacted actions were eligible for 3-4 points. Second, the points were allocated based on relative importance to flood risk management, as determined by the research. For example, in the climate change category, the criterion 'recognition of climate change' is weighted as 1 point because it produces a policy change only and is less integral to flood risk management; on the other hand, the criterion 'restoring wetlands' is weighted as 4 points because it is a specific action and is highly important to flood risk management.

The rationale for this method of distributing points is that following through with a specified action is much more difficult and time-consuming than writing words of acknowledgement into policy documents, which may not even then be acted upon. Most criteria are formatted as yes/no questions; however, some allow for partial scoring if a policy has been created, but it has not been acted upon. The four major categories that case studies are evaluated on are included below:

- Climate Change
- Participation, Engagement and Education
- Integrated Flood Risk Management Approaches
- Policy Delivery and Evaluation

The relevant documents for each case study were examined to evaluate the case study criteria and assign a score to each criterion. These scores were then summed and indexed to a score out of ten for each category to be able to compare case studies on a category basis. The category scores were indexed to ten because the researchers did not identify any one category as more important as all four categories significantly contribute to effectively planning for flood risk management. All the categories were summed to create an overall score out of forty for the case study. A visual representation of this summation can be seen in the image below.

This methodology was created to enable the evaluation of policy while also having enough flexibility to identify promising projects undertaken by other flood management authorities. For the purpose of this assessment all documents published by the flood management authorities were considered to be 'policy' as per the evaluation matrix, regardless of the legal enforceability of those documents. This approach was

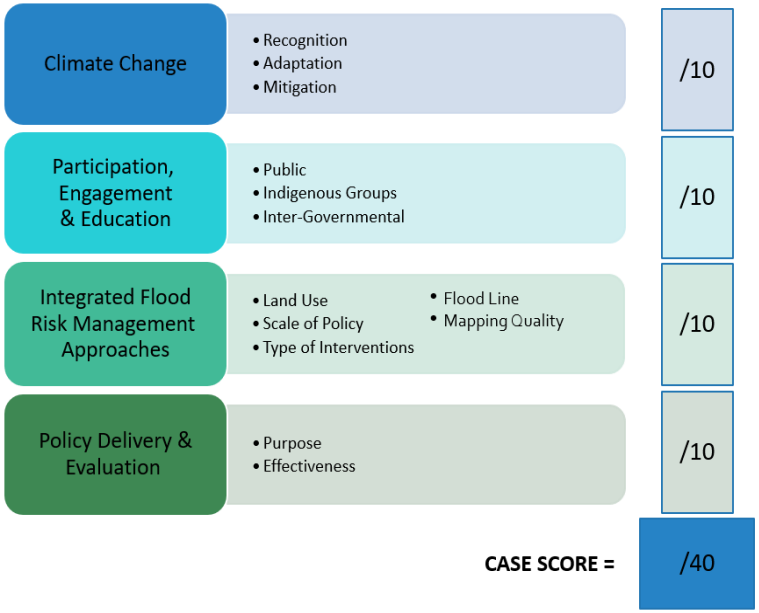


Figure 19: *Breakdown of case study category weighting and point allocation.*

used due to the difficulty of assessing the diverse policy and plan approaches of multiple different flood risk management authorities.

6.3.3 Categories and Descriptions

The following section describes each of the categories and sub-categories chosen for evaluating plans and policies. A rationale explaining the importance of each category and how it relates to land use planning and flood risk management is included. The rationale also outlines how criteria address provincial policy and guidelines. Specific policy planning goals are outlined, as well as important actions flood management authorities should undertake to reduce the hazard of flooding and the risk associated with it.

6.3.4 Climate Change

Climate change was been broken down into three sub-categories: recognition, adaptation, and mitigation. These sub-categories contain ten specific criteria in total, as outlined in Table 7.

Recognition

Climate change is identified as one of the greatest long-term threats to the stability and prosperity of Canadian society. As such, any plans or policies created by flood management authorities should recognize and act to address the issue of climate change. In Ontario, these actions are mandated by the province through the 2020 *Provincial Policy Statement* section 3.1.3 “planning authorities shall prepare for the impacts of a changing climate that may increase the risk associated with natural hazards.” While recognition of climate change is critical, case studies that get the highest scores in this category will have responded to climate change through specific adaptation and mitigation measures.

Adaptation

Climate change adaptation measures respond to the effects of climate change. In the context of flood risk management, adaptation consists of restoration, education, and management actions. Several practical adaptation methods exist. Restoring wetlands so that they can reduce flow speeds and store floodwaters will prevent future floods from being as damaging as they would have been otherwise. Implementing natural stormwater management practices, such as permeable pavements or bioswales, allows water to absorb into the ground. Using natural green infrastructure to slow down water and aid infiltration reduces the downstream effects of flooding. Additionally, preparing the public for the eventuality of flooding and creating programs to communicate flood risk was identified as a critical aspect of flood adaptation.

Mitigation

Climate change mitigation measures reduce the drivers of climate change such as atmospheric CO2 emissions. Although conservation authorities do not directly create large amounts of CO2, they regulate natural areas that can store carbon if adequately cared for. Therefore, any plan to aid the uptake of CO2 from the atmosphere through the management of natural resources can be considered as a positive action to address the effects of climate change.

In the context of flood risk management, communities have historically relied on structural mitigations, including dykes, dams, and other concrete infrastructure to address flooding problems. Although these measures are effective, they only address the problem by moving the floodwaters to alternate locations and not fully mitigating the issue. An additional issue is that such structural measures are expensive to build and require maintenance to operate effectively. For these reasons, flood mitigation through more natural means is desirable. Natural flood mitigation policy actions reduce the effects of flooding through re-naturalizing damaged areas, protecting lands adjacent to riparian corridors, and protecting wetlands which also store large amounts of CO2 in their soils (Mitsch, et al, 2013).

***Table 7**: Climate change evaluation matrix.*

Category	Sub-Category	Criteria	Max Points
Climate Change	Recognition	Does the flood risk management authority recognize climate change? (0) No (1) Yes	(1)
		Does the flood risk management authority recognize the need for sustainable practices? (0) No (1) Yes	(1)
	Adaptation	Have they restored wetlands? (0) No (4) Yes	(4)
		Do they utilize natural stormwater management practices? (0) No (2) Plan but no action (4) Yes, acted upon	(4)
		Do they have a specific flood response plan (in addition to an emergency response plan)? (0) No (1) Yes	(1)
		Do they have any programs to prepare homeowners for a flood (e.g. how to fill a sandbag, power outage preparation, how to floodproof home etc.)? (0) No (2) Education programs (3) Funding & Education programs	(3)
	Mitigation	Do they have a plan to limit/reduce CO2 emissions? (0) No (2) Yes	(2)
		Does the policy recommend protecting wetlands (all – not just provincially significant)? (0) No (2) Yes	(2)
		Do they have any policies that allow them to take public ownership of lands adjacent to riparian areas? (0) No (1) Yes	(1)
		Do they have any programs in place to re-naturalize areas (e.g. tree planting, native species planting)? (0) No	(3)

6.3.5 Participation, Engagement and Education

Participation, Engagement and Education was broken down into three sub-categories according to the types of participants involved: public, Indigenous, and inter-governmental. These sub-categories contain nine criteria in total, as outlined in Table 8.

Public

A large flooding event will require all residents in the affected areas to be able to respond in a timely manner therefore making public education about flood risks and responses a priority. Policies about flooding should be written for the public to be able to easily interpret. During the policy writing process, relevant stakeholders should be sought out and have the opportunity to comment. Ideally the flood risk management authority will also have some ongoing relationship with community groups to manage flood risk. After the policies are written, it is expected that there be a transparent process of evaluation when an application under the policy is submitted. These actions provide trust in the flood risk management plan and encourage public cooperation.

Indigenous Groups

Flooding is a phenomenon that is intrinsically related to the land; therefore, it would be short-sighted to not consult with Indigenous communities. In 2016 Canada endorsed the United Nations Declaration on the Rights of Indigenous Peoples (Government of Canada, 2020). A tenet of this declaration is the duty for governments to obtain free, prior and informed consent on issues that might affect the rights and interests of Indigenous Peoples. In Canada, the duty to consult with Indigenous communities is rooted in section 35 of the 1982 *Constitution Act*, for any action that may adversely impact asserted or established treaty rights. Beyond that, the 2015 *Truth and Reconciliation Commission* has affirmed Canada's commitment to a relationship of respect and cooperation. For these reasons, flood management policies should actively seek out and identify Indigenous communities and provide ongoing opportunities for involvement.

Inter-Governmental

Any successful government policy is expected have a working relationship and open communication with other governing bodies sharing the same geographical jurisdiction. This avoids duplicative errors and unnecessary bureaucracy. For successful communication between government agencies, the policy should clearly outline the relationship with other governing bodies. Doing so not only guides various government bodies on their responsibilities but also outlines whom the public should contact for various issues.

***Table 8**: Participation, engagement and education evaluation matrix.*

Category	Sub-category	Criteria	Max Points
Participation Engagement & Education	Public	Does the policy demonstrate how the public contributed in its creation? (0) No/unknown (2) Yes, stated but no documentation provided (3) Yes, but documentation does not relate to policy (4) Yes, documented well (how they consulted, what the findings were, and how it connected to policy	(4)
		Does the flood risk management authority demonstrate how the public contributes in an ongoing manner? (0) No/unknown (2) Yes, stated but no documentation provided (3) Yes, but documentation does not relate to policy (4) Yes, documented well (how they consulted, what the findings were, and how it connected to policy	(4)
		Do they have a specific flood risk education program for the public? (0) No (3) Yes	(3)
		Is there a public facing document that explains the policy in a way that any member of the public could understand? (0) No (2) Yes	(2)
		Does the policy set out transparent evaluation criteria for when a member of the public submits an application? (0) No (2) Yes	(2)
	Indigenous Groups	Does the flood risk management authority recognize and include traditional knowledge from Indigenous communities? (0) No (1) Collected/obtained but not included in policy (3) Recognized and implemented	(3)
		Does the flood risk management authority actively seek out and identify Indigenous communities and provide opportunity for involvement? (0) No (1) Opportunity to comment but not actively sought out (2) Identifies (3) Identifies and Consults	(3)
	Inter-Governmental	Is there a well-documented relationship and open communication with other governing bodies sharing the same geographical jurisdiction? (0) No (3) Yes	(3)
		Does the flood risk management authority clearly outline the relationship with other governing bodies? (0) No (1) Yes	(1)

6.3.6 Integrated Flood Risk Management Approaches

Integrated Flood Risk Management Approaches were broken down into five sub-categories: land use, scale of policy, type of intervention, flood line, and mapping quality. These five sub-categories contain fourteen criteria in total, as outlined in Table 9.

Land Use

Land use is the single largest driver of flood risk for human settlements. If nothing were built in flood areas, flooding would not have such a significant impact on our communities. However, many areas have historically been built in areas prone to flooding, and it would now be impractical to refuse to build anything in these areas altogether. Therefore, flood management policies should specify areas where is it completely unacceptable to build, such as within the floodplain, and areas where flood risk may be managed through specified land uses or built improvements.

It is highly important that flood management policies also consider their relationship to watershed management policies. The guiding theory of Integrated Flood Management (IFM) addresses flooding from a holistic perspective that considers the entire watershed. By linking flood management on a smaller scale to larger scale watershed management, the greater and more significant cumulative impacts can be recognized and adequately prevented. In this respect, flood management policies should evaluate the impacts of development cumulatively using explicit and consistent criteria, instead of evaluating these impacts on a case-by-case basis. Considering development cumulatively will allow decision-makers to examine what is already built in flood prone areas, preventing additional unnecessary development and limiting necessary development.

Scale of Policy

It is important that flood management policies acknowledge the entire watershed and that the authority responsible for flood management have full authority over decisions regarding flooding within their jurisdiction. Without acknowledging the entire watershed, the effectiveness of flood management strategies will be reduced. Additionally, flood management policies should recognize flooding as only one part of the water cycle that also includes drought and groundwater storage as integrated parts.

Type of Intervention

The type of intervention offered within the policy is evaluated by examining if the approach is solely hazard-based or incorporates risk-based approaches. The regulatory environment in Ontario currently approaches flooding from a hazard-based approach, taking a reactive approach to flooding based on the regulatory flood standards defined by the MNRF.

However, a risk-based approach which considers the vulnerability of areas and land uses to flood hazards is identified as a better approach to managing flood risk within the framework of IFM. In either case, the policy should be based on evidence and not merely follow traditional flood management interventions. By doing so it should consider the climate, basin characteristics, and socio-economic conditions in the region. Encouraging natural interventions such as riverbank naturalization and limiting a reliance on structural interventions for new development are considered important intervention policies.

Flood Line

Jurisdictions in Ontario base their regulatory flood line upon the greater of the 100-year flood or a historically designated storm event. For example, Conservation Sudbury bases their flood line on the 1961 Timmins Storm or 100-year storm, whichever is greater. While this approach allows some flexibility for conservation authorities to adapt to local conditions, it is a solely reactive approach to flooding. As a major goal of flood risk management is to reduce the effect of future flooding, it would be highly beneficial to incorporate the forecasted effects of a changing climate into the regulatory approach. Jurisdictions outside of Ontario may allow for a more proactive approach in response to changing climatic conditions. Any policies that look to take a more proactive approach were deemed worth examining.

Mapping Quality

For either a hazard-based or risk-based approach to managing flooding, having current flood maps is a key consideration. Having maps that cover the full jurisdiction of the flood management authority and that have been updated within at least the last five years will score the most points in this sub-category. Additionally, regulatory flood maps should be easily accessible for the public to access and use.

Table 9: *Integrated flood risk management approaches evaluation matrix.*

Category	Sub-category	Criteria	Max Points
Integrated Flood Risk Management Approaches	Land Use	Is there a consideration for the relationship between land use planning and watershed management in the plan? (0) No (1) Yes	(1)
		How does the plan/document zone/designate lands for flooding and flood risk management? (1) One-Zone concept (Flood zone) (2) Two-zone concept (Flood-Flood Fringe Zones)	(2)
		Does the plan consider existing land uses and strategies within the outlined area (e.g. do they look at what is already there and plan with it, not overtop of it)? (0) No (1) Considers Case-by-case (2) Considers Cumulative impacts	(2)
		Are there policies in place to recommend suitable development practices in the flood fringe (or areas adjacent to floodplains if is a one zone concept)? (0) No (1) Yes	(1)
	Scale of Policy	Does the flood risk management authority have sub-watershed plans? (0) Does not follow watershed boundaries (1) Follows watershed boundaries but does not look at sub-watersheds (2) Has sub-watershed plans or equivalent	(2)
		When making decisions, is the full watershed being considered? (0) Planning without consideration for the rest of the watershed (2) Decision based upon full watershed impacts	(2)
		Does the policy recognize the whole water cycle by addressing drought management and/or water storage as integrated parts of flood management? (0) No (1) Recognized but no policy actions (3) Recognized and enacted in policy	(3)
	Type of Interventions	Is there an evidence-based approach to the policy? (0) No (2) Yes	(2)
		Does the policy only use structural interventions for protecting existing development? (0) New Developments (1) Only for Existing	(1)
		Does the policy encourage natural approaches (e.g. riverine naturalization)? (0) No (1) Yes	(1)
	Flood Line	Is the flood line based on the 100-year flood or is it increasing in response to climate change? (0) 100-year flood (1) Adjusted for Climate Change	(1)
	Mapping Quality	Is the regulatory map easily accessible? (0) No (1) A guidance map is accessible, but it is not the official regulatory map (2) Yes	(2)
		When was the mapping last updated? (0) 10 years ago or more (2) 6-10 years ago (4) 5 years ago, or less	(4)
		Does mapping appear to cover the full jurisdictional area of the policy? (0) No (1) Yes	(1)

6.3.7 Policy Delivery and Evaluation

Policy Delivery and Evaluation was broken down into two sub-categories: purpose and effectiveness. These sub-categories contain five criteria as outlined in Table 10.

Purpose

Any effective policy should define the role of the governing body writing and implementing it. This allows all policy readers to understand why the policy was written and how the governing body intends to enact it. An additional consideration is whether the flood management agency has a vision about their primary goals, and if those goals are centered around managing flood risk.

Effectiveness

Successful policies and projects also have mechanisms built in to evaluate their success, such as objective measurable criteria for evaluating goals. One way for policies and projects to do this is by listing criteria or goals that define success and periodically revisiting those goals as they are achieved or need to be re-evaluated. Additionally, the effectiveness of any policy can be increased by making it more accessible to the public. Having a single comprehensive flood risk management policy document will greatly aid the public in understanding and following the regulations.

6.4 Analysis

Case studies were selected based on the context similarity as outlined in the previous sections. These were then analyzed using the criteria mentioned. A general overview and write up of noteworthy elements of these cases are included in this section along with key takeaways and practices which better inform the final list of recommendations. Case study category scores are colour coded based on the following point allocations:

	0 – 2.4	(Poor)
	2.5 – 5	(Fair)
	5.1 – 7.4	(Good)
	7.5 – 10	(Excellent)

The following section has been broken down into five sub-sections based on geographic location for analysis purposes. These include Northern, Central, Eastern and Southern Ontario, as well as a sub-section for Provincial and International case studies. At the beginning of each sub-section, a summary table is provided outlining overall, context similarity, and category scores for each case study. A more detailed analysis of the case studies can be found in Appendix 2.

Table 10: *Policy delivery and evaluation matrix.*

Category	Sub-category	Criteria	Max Points
Policy Delivery & Evaluation	Purpose	Is the role of the governing body (e.g. the CA) clearly stated? (0) No (1) Yes	(1)
		Does the flood management authority have a vision statement? (0) No (1) Yes (2) Yes, and the vision statement is connected to flood management	(2)
	Effectiveness	Does the flood risk management authority have a timeline to evaluate goals? (0) No (2) Yes	(2)
		Are there measurable criteria to evaluate the progress on goals? (0) No (1) Yes	(1)
		Are all the flood management policies contained within a single document or webpage? (0) No (1) All located on the same webpage (2) All contained within a single document	(2)

6.5 NORTHERN ONTARIO

6.5.1 NORTHERN ONTARIO SCORE SUMMARY

***Table 11**: Summary of Northern Ontario case study scores.*

Flood Risk Management Authority (Context Similarity in Brackets)	**Overall**	**Climate Change**	**Participation Engagement & Education**	**Integrated Flood Risk Management Approaches**	**Policy Delivery & Evaluation**
Northern Ontario	**/40**	**/10**	**/10**	**/10**	**/10**
Conservation Sudbury (10.0)	19.1	5.5	2.8	5.8	5
North Bay-Mattawa Conservation Authority (8.5)	24	5	4.4	5.8	8.8
Lakehead Region Conservation Authority (8.5)	12.3	3.2	0.8	3.3	5
Mattagami Region Conservation Suthority (7.7)	18	3.6	4.4	5	5
Sault Ste. Marie Region Conservation Authoirty (6.9)	20.4	5.9	2	3.8	8.8

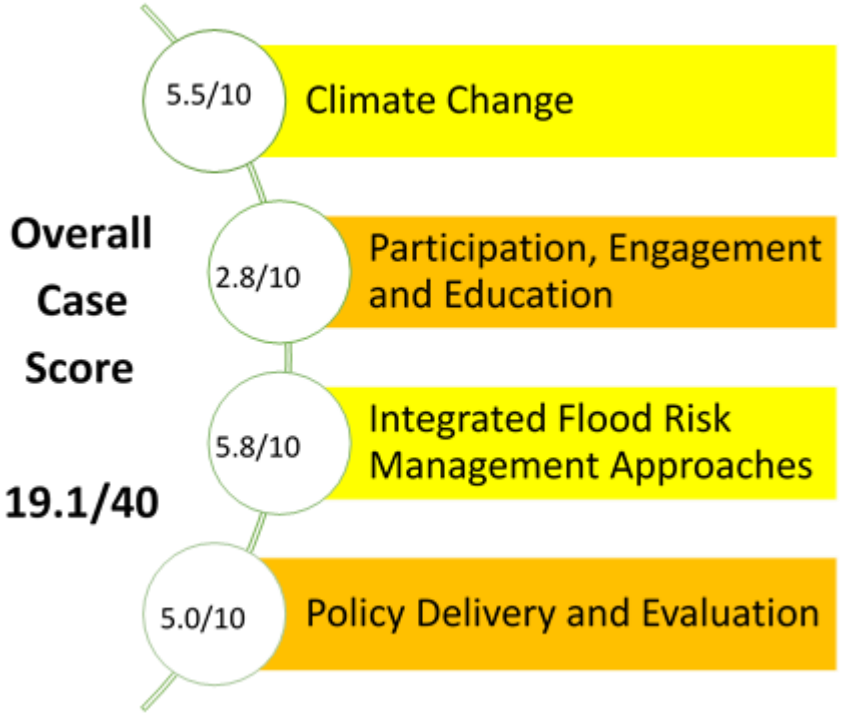
6.5.2 CONSERVATION SUDBURY (BASE CASE STUDY)

Primary Documents Examined

Flood Plain Management Criteria
Flood Plain Management Policy
Conservation Sudbury Strategic Plan 2017-2021
Conservation Authorities Act Section 28 Hearing Procedures:
Nickel District Conservation Authority
Community Flood Management Plan

Key Takeaways

- The current low impact development (LID) pilot project is a good foundation for a natural stormwater management system approach.
- Conservation Sudbury has some good documents pertaining to both flood preparedness and information, as well as floodplain management policy. However, documents and information are either not available to the public or are difficult to find on their website.



6.5.2 CONSERVATION SUDBURY (BASE CASE STUDY)

Introduction

Conservation Sudbury, formerly known as the Nickel District Conservation Authority, is a large conservation authority in Northern Ontario which encompasses the entire City of Greater Sudbury, as well as a substantial area outside of the City boundary. The Authority has jurisdiction within three watersheds: the Wanapitei River Watershed, the Vermilion River Watershed, and the Whitefish River Watershed. These watersheds encompass a total area of 7,576 square kilometres. Conservation Sudbury has outdated floodplain management criteria and policies which they currently use for internal planning and review processes.

Summary Analysis

Some of Conservation Sudbury's greatest strengths are due to its recent activities, such as its tree planting service and its new pilot project on low impact development (LID) exploring how to use natural features and green technologies to reduce the impact of flooding events.

The *Floodplain Management Policy* created in 1990 outlines many useful planning tools, such as the one-zone and two-zone concepts for floodplain management and planning policy. The two-one concept enables two planning policy areas (specifically, a flood zone and a flood fringe) to be overlayed around floodplains, giving the Authority more flexibility and discretion in directing planning activities in and beside floodplains.

In 2017, Conservation Sudbury developed a new Strategic Plan which highlights the goals the Authority would like to achieve, as well as the problem areas it plans to address. Documents like these are helpful and allow an organization to identify its main problem areas and fix them, while continuing to build on skills, tools, and relationships which benefit it the most.

Although Conservation Sudbury has some strengths, it also has areas which are lacking compared to other conservation authorities. Conservation Sudbury would benefit from addressing these areas in the near future. These areas include increasing climate change awareness and action, improving the transparency and public availability of documents, increasing and documenting involvement public participation efforts, updating floodplain mapping, and developing clearer objectives and timelines to evaluate its policy development.

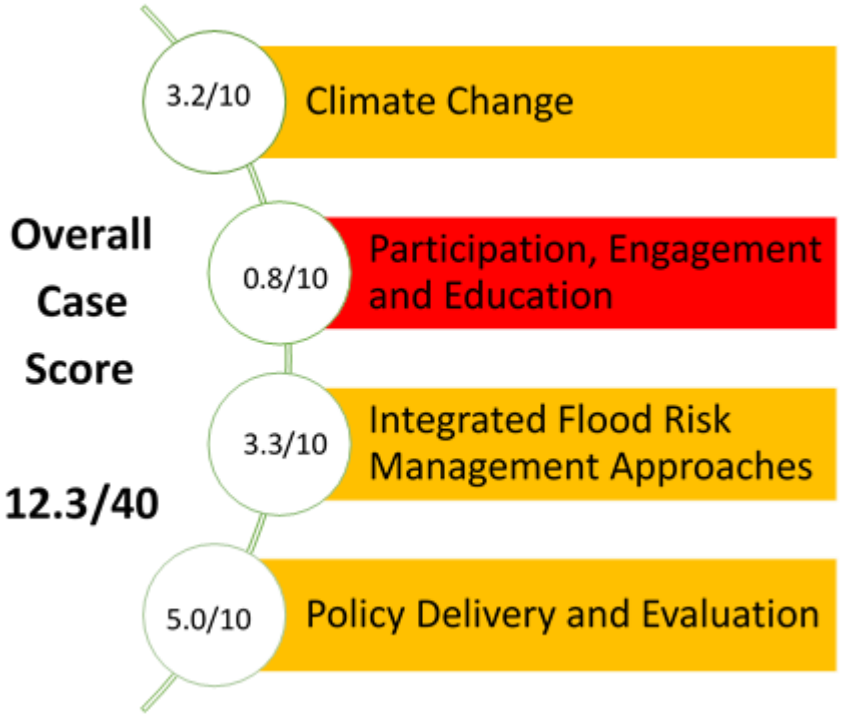
6.5.3 LAKEHEAD REGION CONSERVATION AUTHORITY (CONTEXT SIMILARITY 8.5 / 10)

Primary Documents Examined

Ontario Regulation 180/06. Lakehead Region Conservation Authority: Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses (Amended 2013)
Lakehead Region Conservation Authority: Five-Year Strategic Plan 2018-2022 (2018)
Projects Around the Watershed 2000-2009

Key Takeaways

- Installing public education boards at conservation areas is a good way to communicate with the public.
- Instead of developing their own low impact development guidelines, LRCA directs website visitors to the Credit Valley Conservation Authority's low impact development guidelines and resources page. This allows them to benefit from the work of other conservation authorities.



6.5.3 LAKEHEAD REGION CONSERVATION AUTHORITY (CONTEXT SIMILARITY 8.5 / 10)

Introduction

Lakehead Region Conservation Authority (LRCA) is very similar to Conservation Sudbury as both are located in Northern Ontario, in the same climatic zone, and have a similar population size. Although the region is similar to Conservation Sudbury, it is located on the shore of Lake Superior and as such, it experiences coastal flooding in addition to inland flooding. The jurisdiction area of the LRCA includes: the City of Thunder Bay, the Municipalities of Neebing, Shuniah and Oliver Paipoonge, and the Townships of Conmee, O'Connor, Gillies and Dorion. The total population is about 121,000 and the population density is 44 persons per square kilometre. These factors led to a context similarity score of 8.5/10 for the LRCA. With a similar climatic context, population size, population density and regulatory environment, it is likely that anything LRCA has been able to achieve, Conservation Sudbury should be able to as well.

Summary Analysis

LRCA performed poorly in our evaluation due to a combination of factors. Much of their efforts have been concentrated on environmental protection and monitoring as opposed to flood risk management. They have not made crucial documents available to the public on their website, such as floodplain mapping or a full version of their *Strategic Plan.* They also have not updated their flood management policies beyond what the original Ontario Regulation specifies.

Although the LRCA had some significant shortcomings, it should be noted that it is a small conservation authority with a limited population base, and likely does not possess the resources to address every aspect of flood risk management. Where possible, the LRCA used the work of other conservation authorities to enhance its local services. Rather than developing its own Low Impact Development resources, the LRCA provides a link to the Low Impact Development guidelines and resources page of the Credit Valley Conservation Authority.

Two initiatives at the LRCA stand out. First, LRCA's tree planting initiative has planted over 135,000 trees through the Private Landholders Tree Seedling Assistance Program. This program provides seedlings to landowners at subsidized prices in order to facilitate more tree plantings. Trees generally aid in flood risk adaptation, by slowing water flow and enhancing infiltration. Second, LRCA has undertaken several projects to install public education panels in their conservation areas. This could be an approach for Conservation Sudbury to take to inform the public about flood risk.

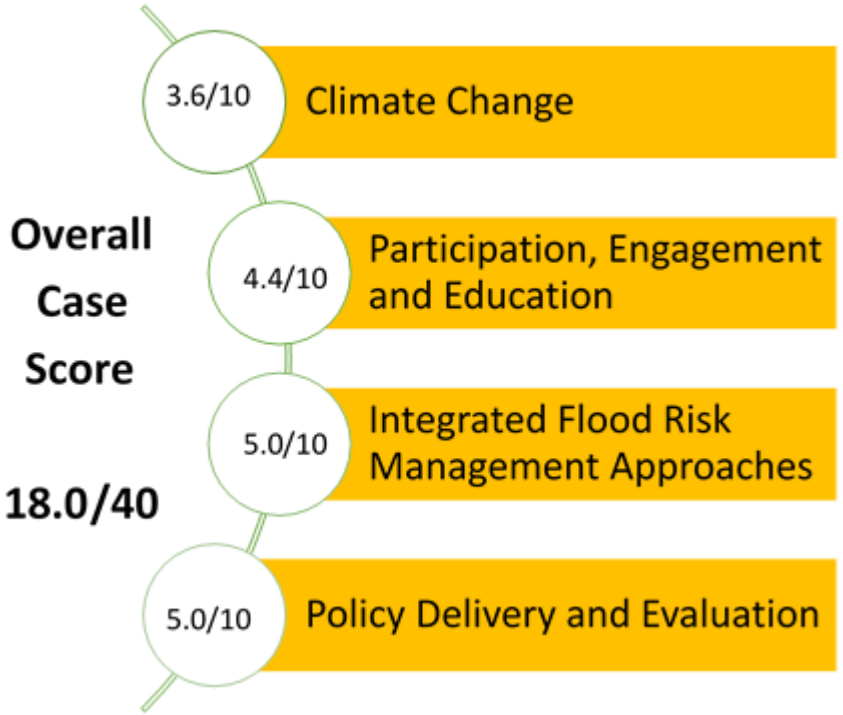
6.5.4 MATTAGAMI REGION CONSERVATION AUTHORITY (CONTEXT SIMILARITY 7.7 / 10)

Primary Documents Examined

Policies for the Administration of the Development, Interference with Wetlands and Alteration to Shorelines and Watercourses Regulation (2014)
Mattagami Region Conservation Authority: 2017 Year in Review (2018)
Mattagami Region Conservation Authority Flood Contingency Plan (2020)
Shoreline Erosion and Stabilization Guide (2019)

Key Takeaways

- Community outreach events such as the yearly "Fun with Water" festival, provide a chance for the MRCA to communicate its purpose to the public and, could be leveraged to communicate flood risks to the community.
- Creating a list of properties most vulnerable to flood risk, and including it in a flood emergency response plan, can help to notify those who need to know first in a flood situation.
- Conditional development zones allow for flexibility in addressing flood risk in previously developed areas.
- MRCA may at its discretion require an agreement on the title of a property when permitting development in flood hazard zones.



6.5.4 MATTAGAMI REGION CONSERVATION AUTHORITY (CONTEXT SIMILARITY 7.7 / 10)

Introduction

MRCA consists of the entire Upper Mattagami River watershed and a portion of the Abitibi River watershed, with an area of over 11,000 square kilometres. The major population centre is Timmins, with Gogama and Shining Tree being other significant population centres. Although its population size and density are lower than Conservation Sudbury, MRCA has been able to create a robust document outlining their administration and compliance policies as a conservation authority. With a similar climatic context and regulatory environment, it is likely that anything MRCA has been able to achieve, Conservation Sudbury should be able to as well.

Summary Analysis

Public outreach at the MRCA is facilitated by a partnership with the Timmins Misiway Healthy Kids Community Challenge program. Together they host a yearly water festival. This "fun with water" event educates its youth about the important role of water in our lives. Events such as this provide an opportunity for public outreach, Conservation Sudbury could create such opportunities as well, and use them to communicate flood risks for community members. Additional education programs are operated in partnership with the Yellow Fish Road program from Trout Canada.

Public communication is also central to some of its planning documentation. In its *Flood Contingency Plan,* the MCRA maintains a list of 560 residential and commercial property owners that are most at risk in a flooding event. In the event of a flood, these people are warned to take adequate precautions. MRCA also creates documents that simplify their policies and recommendations for the public. Its *Shoreline Erosion and Stabilization Guide* quickly and concisely explains why shoreline naturalization is important and how to do it.

Finally, the MCRA also has some interesting policy practices that allow it to address flood risk from a land use perspective. MRCA created two "conditional development zones" where development can happen in the riverine flooding hazard area, provided the proposed development meets certain pre-determined conditions. MRCA may at its discretion require an agreement on the title of a property when permitting development in flood hazard zones. This policy allows future homeowners to be aware that existing buildings are in the floodway and subject to regulation.

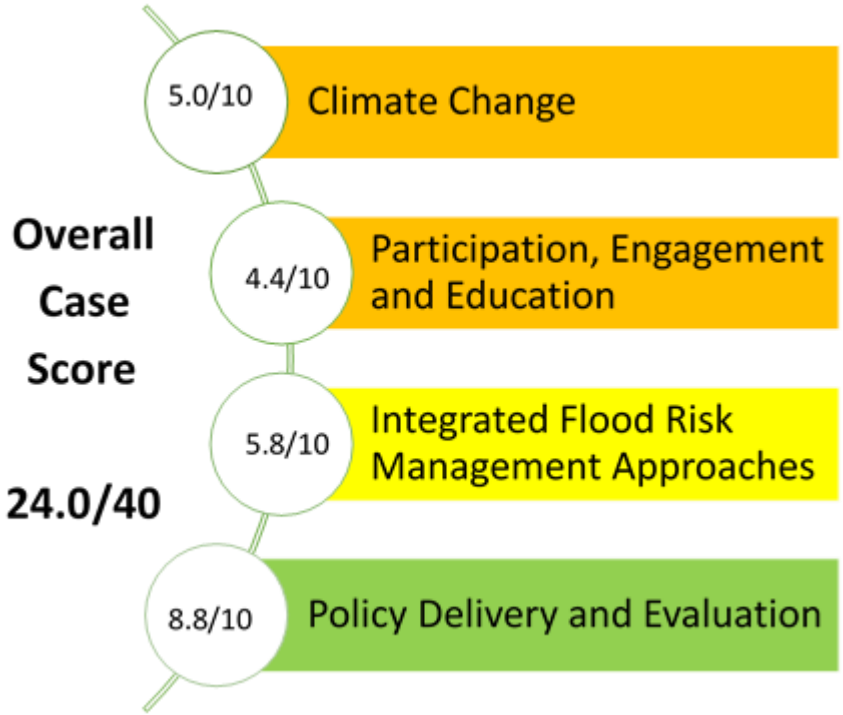
6.5.5 NORTH BAY-MATTAWA CONSERVATION AUTHORITY (CONTEXT SIMILARITY 8.5 / 10)

Primary Documents Examined

Policies for the Administration of Ontario Regulation 177/06 (2020)
Integrated Watershed Management Strategy (2015)
Wetlands Policy (2013)
Checklist – Applying for Permits Under Ontario Regulation 177/06
Hearings and Procedural Manual (2010)

Key Takeaways

- Examining the watersheds on a sub-watershed basis can help to identify local issues that contribute to a better understanding of the entire watershed.
- Creating a checklist of needed application information helps to guide the public towards successful applications.
- Including evidence in policy with a transparent rationale for why that policy exists in the form it does can really improve a policies message when the public is reading it. Including figures helps to communicate the message even more clearly.
- Clear language should be used when writing policy.



6.5.5 NORTH BAY-MATTAWA CONSERVATION AUTHORITY (CONTEXT SIMILARITY 8.5 / 10)

Introduction

North Bay-Mattawa Conservation Authority (NBMCA) is in Northern Ontario, in the same climatic zone as Conservation Sudbury. The region is very similar to Conservation Sudbury and is only located 125 km away. It is inland, with a population of roughly 70,000 and a population density of 13 persons/km^2. These factors contributed to NBMCA scoring an 8.5/10 for its context similarity. Initiatives the NBMCA has been able to complete would likely also work well for Conservation Sudbury.

NBMCA has just released a brand-new policy document, *Policies for the Administration of Ontario Regulation 177/06,* in September of 2020. This comprehensive document is the culmination of many years of work and greatly aids the public in understanding the role and responsibility of the NBMCA. It would be an excellent document to examine when creating future policy plans for Conservation Sudbury.

Summary Analysis

NBMCA is making strides to unify its approach to flood risk management and integrated watershed management. This is a particular strength for the Authority because its *Integrated Watershed Management Strategy* provides a detailed level of information about each sub-watershed under the NBMCA's jurisdiction. Using this approach, NBMCA can understand the drivers of flood risk at a local level and actions that can be taken to address them. This approach seems to work particularly well when setting goals for the future and evaluating those goals in an ongoing process.

Another key strength of NBMCA is their actions on public outreach and communication. Programs such as the *Restore Your Shore* program helped 147 property owners' plant more than 6.5 km of shorelines and streambanks with 29,000 trees, shrubs, and perennials between 2015-2019. Care has been taken to write much of their policy in a way that makes it easy for the public to understand. Figures have been added to the *Policies for the Administration of Ontario Regulation 177/06,* to improve comprehension of policies that could be confusing.

They have improved the transparency of the application process by creating a client checklist for the public to use prior to submitting an application. It outlines what data is needed by the Authority and in what form the data is needed. The checklist also cuts down on the amount of time staff at the CA will have to spend explaining the application process to the public.

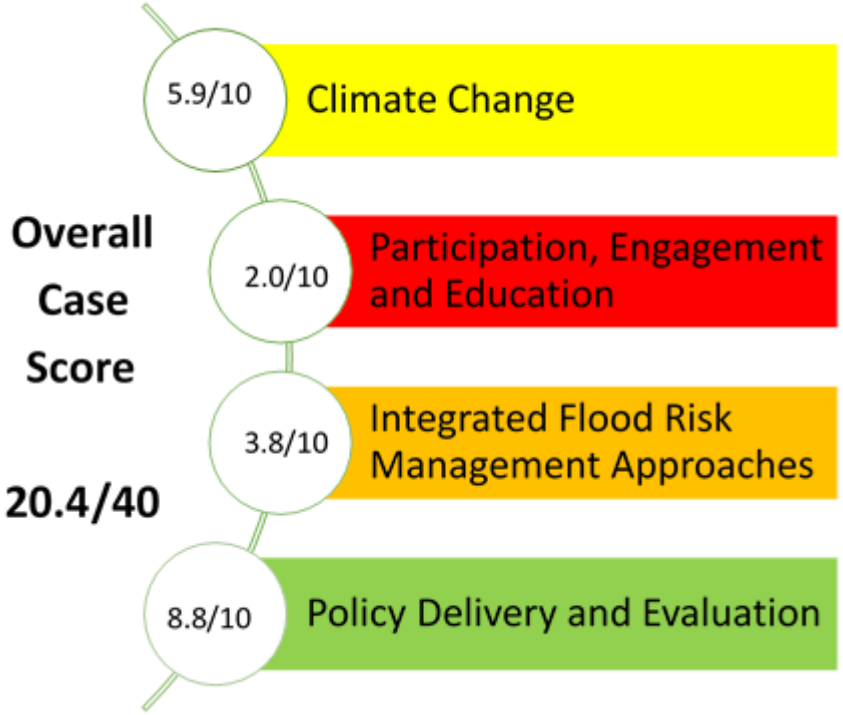
6.5.6 SAULT ST. MARIE REGION CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.9 / 10)

Primary Documents Examined

Policies, Procedures and Guidelines for the Administration of Ontario Regulation 176/06 (2017)
SSMRCA Strategic Plan 2017-2021 (2016)
SSMRCA Annual Report (2017)

Key Takeaways

- Allowing the construction of low-risk land uses in the flood fringe, such as geothermal heating and cooling systems, allows residents to make the best of flood hazard areas.
- Effective flood hazard mapping can be provided to the public by partnering with local municipalities.
- SSMRCA has a marsh monitoring program for private individuals to volunteer to monitor a marsh. SSMRCA lends out the equipment to do so free of charge. This program supports and encourages a public interest in wetland preservation.
- Has recently signed a memorandum of understanding with Sault College for students to complete projects at SSMRCA's conservation areas as part of their coursework (Sault College, 2019).



6.5.6 SAULT ST. MARIE REGION CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.9 / 10)

Introduction

The Sault Ste. Marie Region Conservation Authority (SSMRCA) was created in 1963. It is the smallest conservation authority in Ontario with an area of 552 square kilometres. The jurisdiction of SSMRCA follows the municipal boundaries of the City of Sault Ste. Marie. This area includes the watershed of the St. Marys River, and several smaller watersheds draining into Lake Superior. The area is home to approximately 74,000 people with a population density of 132 persons/sqkm. The SSMRCA is in Northern Ontario and has a similar climatic context to Conservation Sudbury. All these factors contributed to SSMRCA scoring a 6.9/10 on the context similarity evaluation.

Summary Analysis

SSMRCA performed adequately in the evaluation, despite its small size and comparatively low population. SSMRCA has created a robust policy document that covers a wide range of flood risk management aspects. Of all the Northern C conservation authorities, SSMRCA seemed to have th effective and complete policy document. Many guide suggestions for how the public can follow the policies included.

SSMRCA has adopted progressive policies that allow innovative land uses in the flood hazard limit which would not traditionally be permitted. Section 5.3.8 of their policies allow for geothermal heating and cooling systems to be constructed in the flood hazard limit, provided certain conditions are met.

The second significant strength of SSMRCA is its ability to find community partners to aid and enhance service delivery. Screening maps are included on SSMRCA's website through a program called Soo Maps (hosted by Sault Ste. Marie). This mapping tool is useful for the public to see where the regulated flood areas are located and how they relate to other features in the area. Many other layers can be turned on and off including, roads, land parcels, building footprints, heritage sites, and businesses. Sudbury Conservation may be able to partner with the City of Sudbury on such a mapping initiative to improve their maps.

SSMRCA encourages private individuals to volunteer to

6.6 CENTRAL ONTARIO

6.6.1 CENTRAL ONTARIO SCORE SUMMARY

Table 12: *Summary of Central Ontario case study scores.*

Flood Risk Management Authority (Context Similarity in Brackets)	**Overall**	**Climate Change**	**Participation Engagement & Education Score**	**Integrated Flood Risk Management Approaches**	**Policy Delivery & Evaluation**
Central Ontario	**/40**	**/10**	**/10**	**/10**	**/10**
Kawartha Conservation (9.2)	30.9	7.7	4.4	8.8	10
Otonabee Region Conservation Authority (9.2)	26.7	7.1	7.1	7.5	6.3
Ganaraska Region Conservation Authority (6.9)	16	3.2	2.8	5	5
Nottawasaga Valley Conservation Authority (6.9)	20.6	6.8	6.7	5.8	1.3
Lake Simcoe Region Conservation Authority (6.2)	26.5	8.2	4.2	5.4	8.8

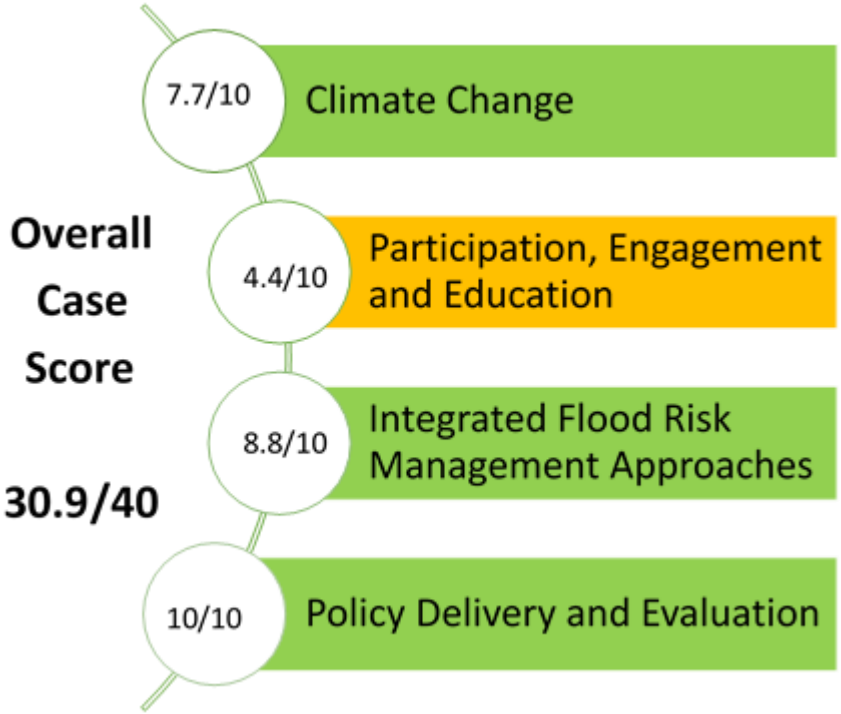
6.6.2 KAWARTHA CONSERVATION (CONTEXT SIMILARITY 9.2 / 10)

Primary Documents Examined

Climate Change Strategy (2016)
Kawartha Conservation Strategic Plan 2017-2021 (2016)
Kawartha Conservation Stewardship Strategy 2020-2030 (2020)
Plan Review and Regulation Policies (2013)
BlueScaping Our Neighbourhoods

Key Takeaways

- A comprehensive climate change strategy document is highly useful in informing and addressing larger global climate change issues facing local conservation authorities.
- Utilizing a singular document which outlines ways which property owners can benefit the environment and decrease flood risk makes community involvement in environmental efforts less intimidating and easier to understand for the public.
- Increasing ease of access to mapping is a useful focus for CAs as it improves community interaction with CA websites and resources.
- Goals and objectives which are measurable, transparent, and time-oriented aid in completing action items.



6.6.2 KAWARTHA CONSERVATION (CONTEXT SIMILARITY 9.2 / 10)

Introduction

Kawartha Conservation is a relatively small conservation authority with jurisdiction of a singular watershed which is approximately 2,563 square kilometres and includes 6 member municipalities. Altogether the municipalities within Conservation Kawartha's jurisdiction make up a total population of 214,921. However, Clarington which is the largest municipality has only a small portion of its boundaries within the jurisdiction of Kawartha Conservation, making the total population estimate <150,000. The main municipality within Conservation Kawartha is the City of Kawartha Lakes, with a population of 75,000 people. Based on the geographic location, size, and population, Kawartha Conservation scored a 9.2/10 on context similarity in comparison to Sudbury.

Summary Analysis

Kawartha Conservation has several noteworthy documents which may be useful for Conservation Sudbury. Examples include a *Climate Change Strategy* and unified policy document, a 10-year stewardship strategy with a list of goals and objectives, as well as a "Bluescaping" or property naturalization document. Each one of these documents provide information which has resulted in beneficial local works that may be highly applicable to Conservation Sudbury's jurisdiction.

Although these documents are effective overall, Kawartha Conservation documents little or no reference to Indigenous knowledge or inclusion. As well, Kawartha Conservation has no information pertaining to public flood risk programs or subsequent information on how to best prepare for a flood.

The mapping and document accessibility of Kawartha Conservation is one of the attributes of the website and CA overall. The mapping is fully open to the public without compromising privacy or security, while using the same mapping software as Conservation Sudbury (CAmaps).

Kawartha Conservation is a strong example of what is achievable by a conservation authority with a smaller population size. Kawartha Conservation has created many documents which would be highly educational and useful to Conservation Sudbury moving forward and should be further studied and researched.

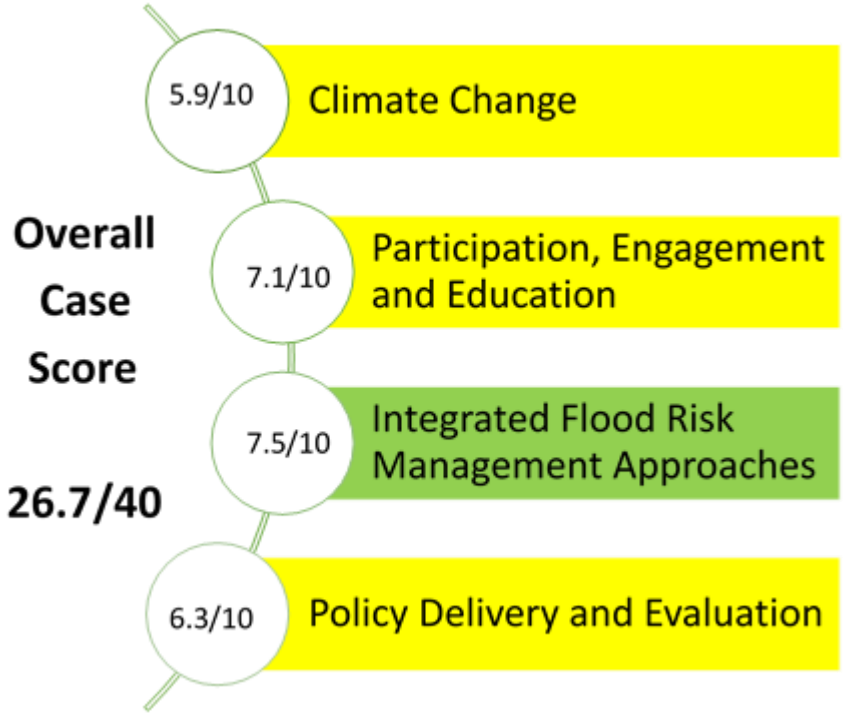
6.6.3 OTONABEE REGION CONSERVATION AUTHORITY (CONTEXT SIMILARITY 9.2 / 10)

Primary Documents Examined

2019 Annual Report to the Watershed Community (2019)
Otonabee Conservation Strategic Plan 2017-2020 (2016)
Watershed Planning & Regulations Policy Manual (2012, updated in 2015)

Key Takeaways

- Policy and guideline documents which are written in a transparent and easily understandable format for the public are highly valuable tools to provide a deeper understanding of flood management within communities.
- Using LiDAR data is a strategy which can be used to create more accurate flood mapping which may aid in better flood predictions and planning for CAs.
- Partnering with local school boards and municipalities are useful and inexpensive way to implement education and planting programs that aid in naturalization and stormwater retention projects.



6.6.3 OTONABEE REGION CONSERVATION AUTHORITY (CONTEXT SIMILARITY 9.2 / 10)

Introduction

The Otonabee Region Conservation Authority (ORCA) is a relatively small conservation authority with a jurisdictional area of approximately 1,950 square kilometres in size with a total population of 105,000 people. There are eight municipalities contained within the ORCA jurisdiction. Otonabee Conservation is similar to Conservation Sudbury as both contain one large primary municipality, similar population and density, and are both located inland with contained lakes and rivers. At ORCA the large urban area is the City of Peterborough, which has around 82,000 citizens as per the 2016 Census. Due to these similarities the ORCA has a context similarity score of 9.2/10.

Summary Analysis

The Otonabee Region Conservation Authority has a strong and unified approach to flood risk management while being transparent and educational. The ORCA works directly with member municipalities as well as local school boards to naturalize the watershed. They do this by educating school children with a "Spring Water Awareness" program in partnership with Ontario Power Generation and by getting local schools and students directly involved in tree planting programs as seen in October of 2020 when local students planted 350 trees around a municipal drainage pond (See news example).

The ORCA's *Watershed Planning & Regulations Policy Manual* is a significant document developed by the Conservation Authority in 2012 and later updated in 2015. This policy manual guides development within the watersheds controlled by the ORCA and provides public awareness on the ORCA's watershed policies. The ORCA has designed the policy manual to include additional paragraphs and examples to explain to technical language in an easily understandable format. This is an example of the style of document Conservation Sudbury could extract lessons from.

The ORCA has a limited mapping section on the website, which only allows the public to download a large physical copy of the entire watershed. However, the ORCA is currently updating its mapping using new LiDAR imaging to make 3D images of shorelines and waterways within the jurisdiction which may be a useful consideration for Conservation Sudbury.

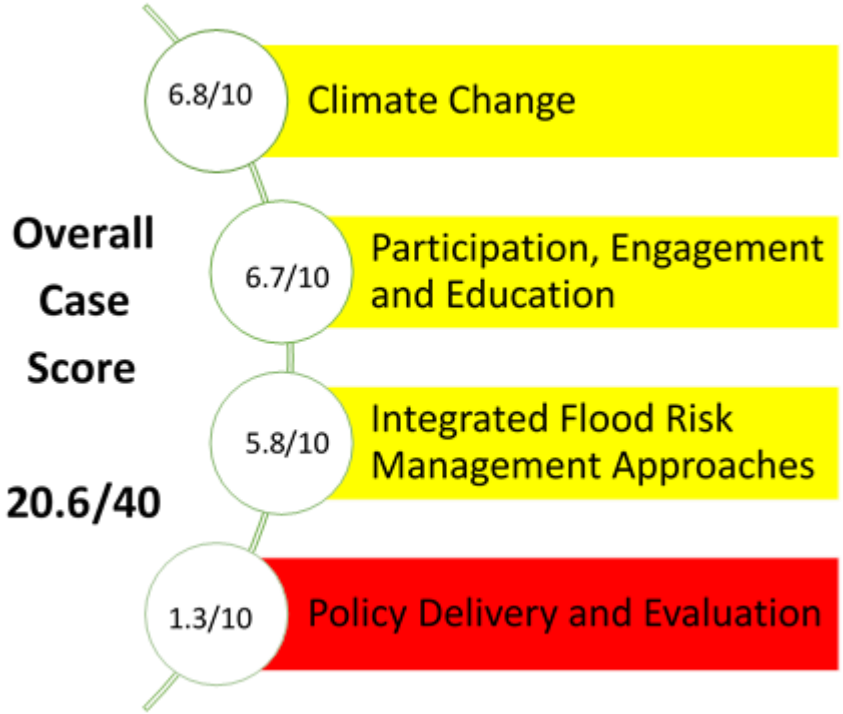
6.6.4 NOTTAWASAGA VALLEY CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.9 / 10)

Primary Documents Examined

Nottawasaga Valley Conservation Authority 2020 Program Overview
Nottawasaga Valley Integrated Watershed Management Plan 2019
NVCA Climate Change Strategy and Action Plan 2016-2018
Nottawasaga Valley Conservation Authority Flood Contingency Plan 2017
NVCA Natural Hazards Technical Guide 2013

Key Takeaways

- Implementing a Climate Change Strategy and Action Plan is one way in which climate change can be incorporated into policy.
- Utilizing an Integrated Watershed Management Approach can incorporate multiple flood risk management strategies to create comprehensive planning practices.
- Engaging and partnering with a variety of sectors in both public and private corporations creates a stronger community of support for flood risk management.



6.6.4 NOTTAWASAGA VALLEY CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.9 / 10)

Introduction

The Nottawasaga Valley Conservation Authority (NVCA) is located in central Ontario. It covers approximately 3,700 square kilometres and has jurisdiction in 18 municipalities in the counties of Simcoe, Dufferin, and Grey. The Nottawasaga Valley is the source of watercourses that flow into Georgian Bay at Wasaga Beach, Collingwood, and Severn Sound. The watershed includes 35 kilometres of the Georgian Bay shoreline.

Agriculture (47%) is the dominant land use in the watershed followed by forests (23%), wetlands (12%), and transitional uses (9%). Urban areas compose 4% and roads compose 3%. The remaining 2% consists of golf courses, water, and quarries. The area's economy is dependent on natural capital as there is a strong tourism industry with some of the larger attractions being Wasaga Beach and ski hills and resorts. The area under jurisdiction of the NVCA has a similar population and population density to that of Sudbury giving it an adequate context similarity. However, this is lowered by the significant portion of coastline along the Georgian Bay which decreases focus on inland flooding and increases documentation and focus on coastal flooding practices. Therefore, the context similarity score is 6.9/10.

Summary Analysis

The NVCA has been successful in multiple areas of focus including planning for climate change, protecting ecologically significant sites, documenting stakeholder participation in policy creation, using an integrated flood management approach, and utilizing LID. The NVCA has multiple plans and programs in place and under development to address these focuses such as a *Climate Change Strategy and Action Plan*, *Land Securement Strategy*, and *Integrated Watershed Management Plan*.

Areas where the Authority did not succeed in providing resources that are useful to this report include flooding education and preparation for the public, consideration for cumulative impacts in the watershed, and incorporating traditional ecological knowledge into policies. The Authority does not make it clear that one of their primary roles is to protect people and property, and while they have strategies and plans in place, many are lacking measurable deliverables and clear timelines. Lastly, locating important information and documents on their webpage can be challenging, posing barriers for the public to access information.

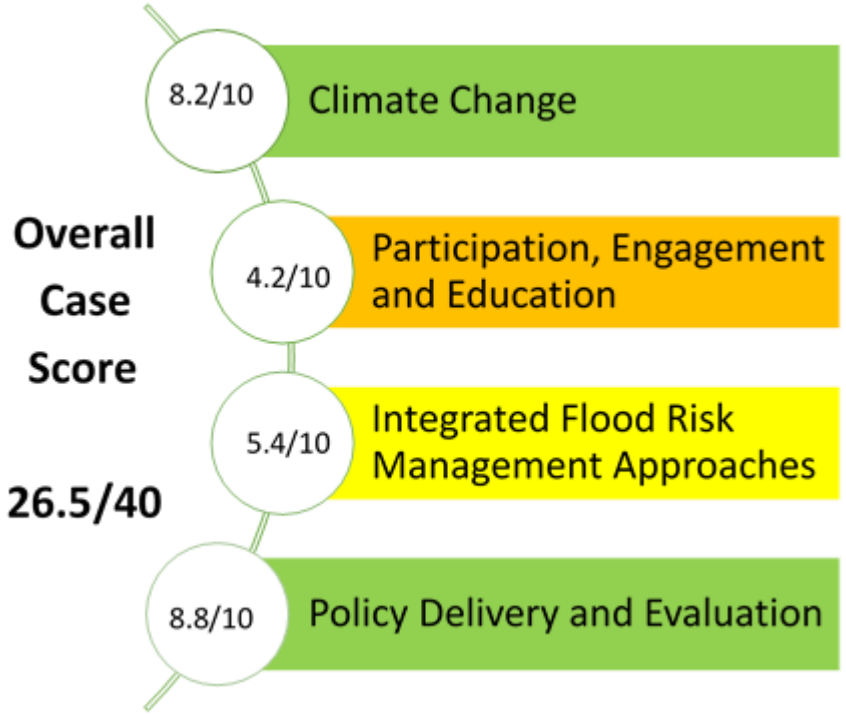
6.6.5 LAKE SIMCOE REGION CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.2 / 10)

Primary Documents Examined

Lake Simcoe Region Conservation Authority Watershed Development Guidelines
LSRCA Technical Guidelines for Stormwater Management Submissions
LSRCA 2016-2020 Strategic Plan
Climate Change Mitigation Strategy for the Lake Simcoe Watershed

Key Takeaways

- Conducting an inventory of GHG emissions and carbon sequestration in the watershed.
- Partnerships with universities to conduct research provide low cost-effective methods of advancing knowledge and information.
- Updates to regulation mapping on an annual basis provide accurate representation of current conditions.
- The requirement for development to utilize LID as well as demonstration projects effectively communicates the importance of LIDs in flood risk management.



6.6.5 LAKE SIMCOE REGION CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.2 / 10)

Introduction

The Lake Simcoe Region Conservation Authority (LSRCA) is located in central Ontario. The Lake Simcoe Watershed is 3,400 square kilometres in size, with Lake Simcoe covering 722 square kilometres of this area. Within the watershed there are 18 subwatersheds and major river systems. The LSRCA has jurisdiction in 20 municipalities with over 450,000 residents. It spans from the Oro Moraine in the north to the Oak Ridges Moraine in the south. York and Durham regions, Simcoe County, and the cities of Kawartha Lakes, Barrie and Orillia are also incorporated in the jurisdictional area. This is one of the fastest growing regions in Canada. The local economy has a large tourism and recreation sector, as well as industry and agriculture. Their context similarity score to Conservation Sudbury is 6.2 due to the population and density similarities.

Summary Analysis

The LSRCA has multiple effective plans and policies in place relating to; planning for climate change, protecting natural heritage systems, requiring stormwater submissions to include LID, and recognizing that Traditional Ecological Knowledge is valuable. Their *Watershed Development Guidelines* document is an extremely useful resource that contains transparent evaluation criteria for applications and all information relevant to flooding that the public may find useful. Another action the Authority has taken is to update their regulation mapping on an annual basis, which is uncommon across Ontario CA's. The LSRCA has also made their role very clear in policy and explicitly makes the connection between flooding and land use planning.

The Authority has room for improvement in the areas of public education and preparation for flooding, defining relationships with other government bodies, and general transparency. Information and key documents were difficult to locate on the webpage; in some cases, documents such as the *Integrated Watershed Management Plan* were mentioned but could not be found at all. The policies themselves are also missing the connection between land use and flooding.

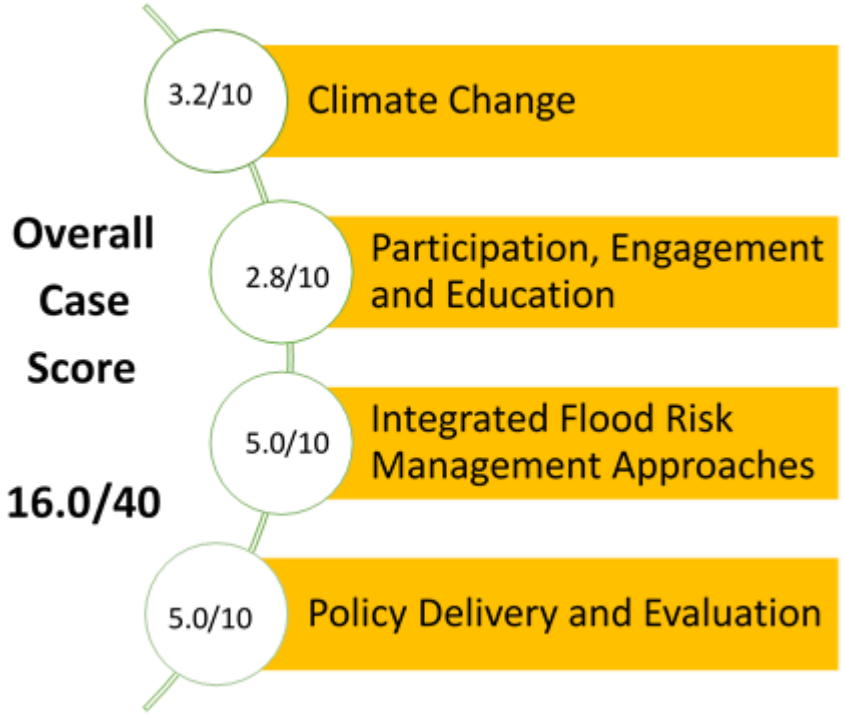
6.6.6 GANARASKA REGION CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.9 / 10)

Primary Documents Examined

Policies for the Implementation of Ontarion Regulation 168/06
Ganaraska Conservaiton Strategic Plan 2015-2020
Ganaraska Region Conservaiton Authority Watershed Report Card 2018
Ganaraska River Watershed Plan 2010

Key Takeaways

- The creation of watershed plans which incorporates scientific research, local knowledge, municipal and agency input, and public consultation allows for focused goals and objectives for policy to conserve the hydrological and ecological integrity of the watershed.
- The creation of a Community Advisory Committee which allows for public input into plans is an effective way to ensure continual and meaningful input of community members and instill a sense of accountability and importance.
- Leveraging relationships with surrounding municipalities and the provincial government to take on planting initiatives allowed the GRCA to create a stronger and more distinguished program that is more well known to the public.



6.6.6 GANARASKA REGION CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.9 / 10)

Introduction

The Ganaraska Region Conservation Authority (GRCA) is located in Central Ontario along the shores of Lake Ontario. The region is slightly different than Conservation Sudbury as it is considered a costal location. However, despite being a coastal conservation authority, the GRCA has jurisdiction over one river, one inland lake, and multiple creeks inland. The GRCA has jurisdiction over approximately 935 square kilometres with a population density of 25-100 persons per square kilometre. Therefore, despite being located outside of Northern Ontario and being located along a coastline, the GRCA is relatively similar to Conservation Sudbury based on demographic profiles and received a context similarity of 6.9/10.

Summary Analysis

The first major contribution to addressing flood risk management was the creation of watershed plans such as the *Ganaraska River Watershed Plan*. This plan incorporates scientific research, local knowledge, municipal and agency input, and public consultation. This allowed for focused goals and objectives for policy to conserve the hydrological and ecological integrity of the watershed. In the *Ganaraska River Watershed Plan* the document utilizes an abiotic, biotic and cultural features background report, in addition to local knowledge, municipal and agency input, and public consultation. This resulted in a list of recommendations, goals, and objectives related to surface water quantity and quality, terrestrial natural heritage, and public health and well-being.

The GRCA also utilized a community advisory committee when creating documents such as the *Ganaraska River Watershed Plan*. This committee was able to review and put input into the document, allowing for public engagement that may be missing from policy creation. Having the community aid in the creation of goals and objectives within the watershed is a great way to not only receive additional feedback, but also to engage with the community in ways that may not otherwise be possible.

Finally, the GRCA has successfully leveraged relationships with local and regional municipalities within its jurisdiction and the provincial government to take on tree planting initiatives. In addition to partnering with local municipalities, the GRCA has leveraged the Durham Region 5 million tree and province of Ontario 50 million tree programs to plant 38,000 trees in their watershed in 2019.

6.7 EASTERN ONTARIO

6.7.1 EASTERN ONTARIO SCORE SUMMARY

Table 13: *Summary of Eastern Ontario case study scores.*

Flood Risk Management Authority (Context Similarity in Brackets)	**Overall**	**Climate Change**	**Participation Engagement & Education**	**Integrated Flood Risk Management Approaches**	**Policy Delivery & Evaluation**
Eastern Ontario	**/40**	**/10**	**/10**	**/10**	**/10**
Rideau Valley Conservation Authority (6.2)	25	9.1	4.6	7.5	3.8
South Nation Conservation Authority (6.9)	25.6	7.7	5.4	7.5	5
Mississippi Valley Conservation Authority (9.2)	21.6	5.9	2.4	8.3	5
Cataraqui Region Conservation Authority (7.7)	17.4	5	2	5.4	5

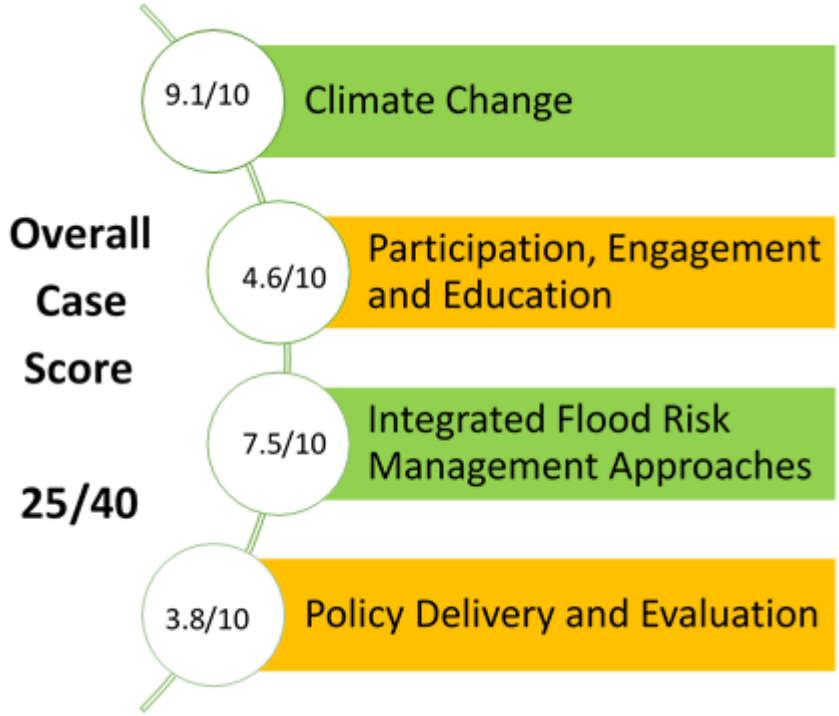
6.7.2 RIDEAU VALLEY CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.2 / 10)

Primary Documents Examined

RVCA Strategic Plan 2020
Guideline for shore works in the Rideau Valley Watershed (2014)
RVCA Wetland Policies (2018)
Policies Regarding Development Including the Construction/Reconstruction of Building and Structures, Placing of fill and to Waterways under Section 28 of the Conservation Authorities Act of Ontario (2010, updated in 2018)
Sub-watershed reports

Key Takeaways

- Wetland policies are easy to read as they are written in plain language and use diagrams to illustrate local flooding issues, causes, and solutions.
- Easily accessible guidelines, checklists, and videos which outline minimum requirements for development applications have been successfully utilized to engage residents in flood risk management practices.
- A collaborative approach is used to engage the community such as partnerships with local school boards to connect with school aged children about the effects of flooding and flood safety.



6.7.2 RIDEAU VALLEY CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.2 / 10)

Introduction

Rideau Valley Conservation Authority encompasses the nation's capital city of Ottawa and its surrounding municipalities, making it one of the largest CAs in the province. The RVCA's watershed covers approximately 4,234 square kilometres. It is located inland and therefore experiences some similar flooding issues as Sudbury. The area encompasses Ottawa's urban core along with smaller municipalities in the surrounding area. The population density is 335 people per square kilometre and the total population of the area is 934,243. The urban centre of Ottawa helps to explain the much higher population and population density in comparison to Sudbury, but the inland and geographic location make the context similarity a 6.2/10.

Summary Analysis

Rideau Valley Conservation Authority (RVCA) uses a collaborative approach to flood risk management by working with local school boards, neighbouring conservation authorities, and municipal and provincial government bodies.

The RVCA wetland policies clearly outline the importance of wetlands including the legislation that regulates them and how property owners, developers and the public can work together to protect wetlands and prevent or prepare for local flood events. The plain language and user-friendly checklists help the public to understand and implement effective flood risk management practices on their own. RVCA has also undertaken multiple wetland restoration projects which have been celebrated by the local community as excellent demonstrations of watershed stewardship. The 2016 Black Rapids Wetland Restoration Project was one of the most celebrated wetland restoration projects in the area. The RVCA collaborated with the National Capital Commission and the Great Lakes Guardian Community Fund to design and expand the wetland in Ottawa's Greenbelt. The project was completed in 2016 with the size of the wetland more than doubling from 3,444 square metres to 7,000 square metres since then.

Lastly, the RVCA's GIS mapping tool has created the option to have flood risk data readily available to all residents. The mapping tool includes various layers such as sub-watershed locations, water quality measurements, flooding hazards, and flow and water levels in the area. Conservation Sudbury can help improve their relationship with the public by considering adopting some of the mapping tools used by Rideau Valley Conservation Authority and improving the availability of flood risk related information on a broader scale.

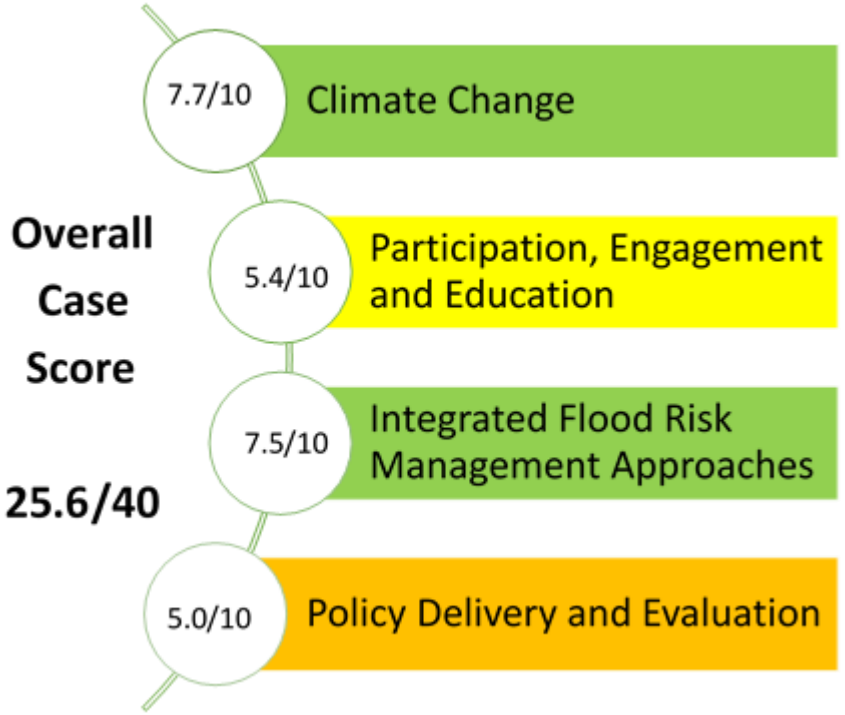
6.7.3 SOUTH NATION CONSERVATION (CONTEXT SIMILARITY 6.9 / 10)

Primary Documents Examined

Development, Interference & Alteration Regulations
Ontario Regulation 170/06: Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses
Canada's Changing Climate Report (2019)
State of the Nation Report (2014)
Flood Contingency Plan (2020)

Key Takeaways

- Wetland policies are easy to read and use plain language and diagrams to explain local flooding issues, causes, and remedies.
- Opportunities for community members to work in a collaborative setting to address conservation concerns provides meaningful results that create a sense of community involvement.
- Innovative methods for stormwater management present new opportunities to address flooding and watershed issues that may present new opportunity in areas which cannot apply traditional methods.



6.7.3 SOUTH NATION CONSERVATION (CONTEXT SIMILARITY 6.9 / 10)

Introduction

South Nation Conservation (SNC) is located in eastern Ontario and is comprised of 16 membership municipalities. The South Nation Watershed covers approximately 4,441 square kilometres with a population of 21,346 people according to the 2016 Census. The population density of SNC is very similar to Conservation Sudbury with 1,023 people per square kilometre. The proximity to Ottawa's urban centre and significant agricultural land and forests create a population density which is like the Conservation Sudbury jurisdiction and therefore, receives a context similarity of 6.9/10.

Summary Analysis

South Nation Conservation uses a collaborative approach to flood risk management through work with local universities, neighbouring conservation authorities, and municipal and provincial government bodies. One way which the SNC engages the public and brings awareness to watershed issues is through the St. Lawrence River Student Summit. The students are provided an opportunity to learn about managing natural resources, invasive species removal, and water quality testing. This is a tool which has potential to be applied specifically to flood risk management practices and programs to educate and inform youth.

SNC also makes efforts to highlight the diverse views and needs of their community through the Forest Conservation Working Group. The working group includes representatives from Indigenous groups, local developers, municipal representatives, community farmers, and other local groups. Although the advisory group is not directly linked to flood risk management, a collaborative approach like this can assist in bringing new perspectives to policy development while building empathy and encouraging stewardship amongst local groups.

Lastly, the SNC has started innovative restoration projects including the Floating Wetland Project that has the potential to change the way stormwater ponds are treated. Floating wetlands are an eco-friendly option for reducing pollutants and algae infestation in stormwater ponds without the use of harsh chemicals. This project has been monitored over the past 6 years and has shown great success in reducing the algae production and pollution levels in the small community of Limoges. This is an initiative that could be duplicated in the Sudbury context to increase biodiversity in smaller wetland areas and provide an alternative method to maintain wetlands for flood management uses.

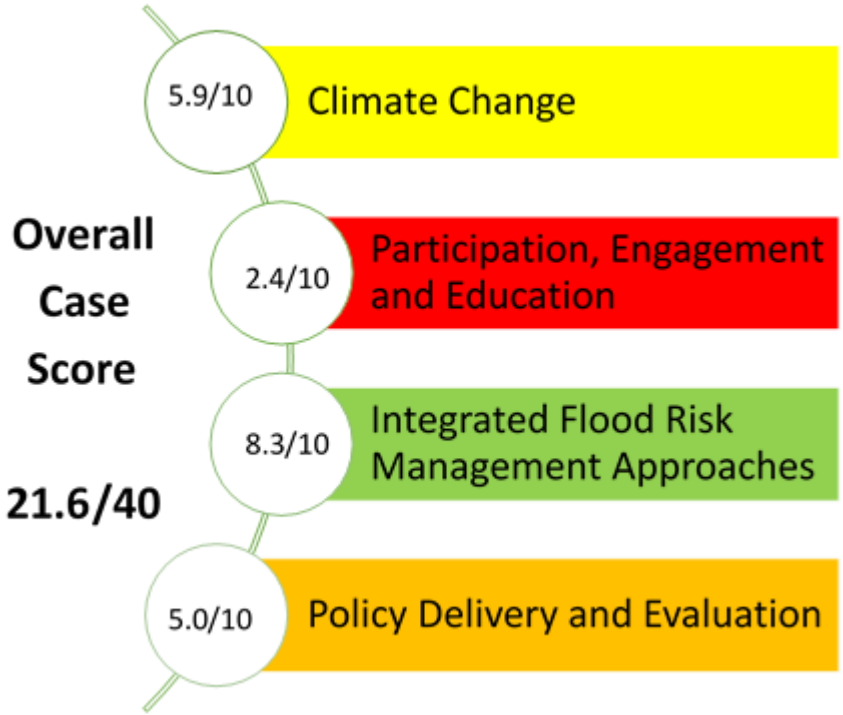
6.7.4 MISSISSIPPI VALLEY CONSERVATION AUTHORITY (CONTEXT SIMILARITY 9.2 / 10)

Primary Documents Examined

Development, Interference with Wetlands and Alteration to Shores and Watercourse – Regulation Policies
Mississippi Conservation Authority – 2018 Annual Report
Watershed Management on a Watershed Basis: Implementing an Ecosystem Approach
Interactive Regulatory Map
Shoreline Permit Application Framework
Mississippi Valley Conservation Authority Permit Process for Flood Recovery

Key Takeaways

- The use of explicit development regulating policy that are reinforced by further guidelines and design standards are an effective method of policy development and implementation.
- Development policy related specifically to size and type of development in non-provincially significant wetlands is a tool which can be utilized to show emphasis on the importance of all wetlands in a specific jurisdiction.



6.7.4 MISSISSIPPI VALLEY CONSERVATION AUTHORITY (CONTEXT SIMILARITY 9.2 / 10)

Introduction

The Mississippi Valley Conservation Authority is located in Eastern Ontario in the Ottawa Valley. It is located inland with four rivers and multiple lakes similar to the system seen in the Conservation Sudbury jurisdiction. The Mississippi Valley Conservation Authority has jurisdiction over approximately 4,450 square kilometres with a population density of 25-100 persons per square kilometre. Therefore, despite not being located in Northern Ontario the MVCA still received a context similarity of 9.2/10 due to the similar population and geographic profile.

Summary Analysis

The Mississippi Valley Conservation Authority has done an exemplary job creating an integrated flood management policy document in the creation of the *Development, Interference with Wetlands and Alteration to Shores and Watercourse – Regulation Policies*. What makes this document successful is the creation *Floodproofing Guidelines and Design Standards* which work in unison with the flood fringe policies. Additionally, the MVCA has successfully addressed the size and hydraulic connectivity of non-provincially significant wetlands to ensure they are protected. The MVCA operates under a two-zone approach and has created a Floodproofing Guidelines and Design Standards document as part of the Development, Interference with Wetlands and Alteration to Shores and Watercourse – Regulation Policies document. This regulates the type of development in the floodway and flood fringe. The guideline and design standards note general flood proofing principles, safe access/egress, design requirements of residential/habitable buildings and non-residential buildings, fill aprons for floodproofing building, drainage swales, and swimming pools. The creation of this document allows for policy to have more of a significant ruling as it sets out the standard for buildings making it easier to distinguish a good development from a bad one within the floodplain.

Lastly, the MVCA has successfully created policies and criteria to protect non-provincially significant wetlands. Within the Development, Interference with Wetlands and Alteration to Shores and Watercourse – Regulation Policies the MVCA notes the need to protect wetlands over 0.5 hectares in size that are connected to a waterbody or watercourse. Through setting size and connectivity criteria, the MVCA is able to preserve and regulate non-provincially significant wetlands. The creation of such criteria allows the MVCA's policy to be actionable and therefore extremely useful if these criteria are not met.

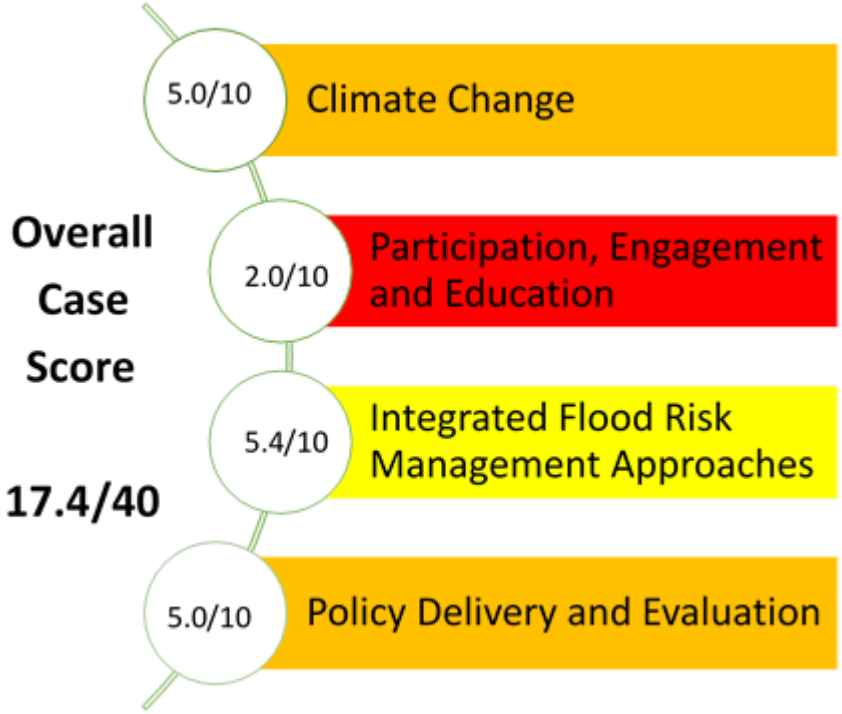
6.7.5 CATARAQUI REGION CONSERVATION AUTHORITY (CONTEXT SIMILARITY 7.7 / 10)

Primary Documents Examined

Guidelines for Implementing Ontario Regulation 148/06: Development, Interference with Wetlands, and Alterations to Shorelines and Watercourses (2017)
Cataraqui to 2020
Service Delivery Procedures for Ontario Regulation 148/06 (2018)
Environmental Planning Policies (2015)

Key Takeaways

- Planting trees, suppling native species for plant nurseries, and utilizing partnerships with the provincial government are highly effective methods to address flood risk management.
- Supplemental policies such as *the Service Delivery Procedures for Ontario Regulation 148/06* and *Environmental Planning Policies* are effective in providing applicants transparency and information on the application process.
- The use of secondary documents such as *Environmental Planning Policies* are effective ways to strengthen and reinforce the intent of policy directed towards flood risk management.



6.7.5 CATARAQUI REGION CONSERVATION AUTHORITY (CONTEXT SIMILARITY 7.7 / 10)

Introduction

The Cataraqui Region Conservation Authority (CRCA) is located in Eastern Ontario along the shores of Lake Ontario. Although different from Conservation Sudbury as it is a coastal CA, the CRCA has jurisdiction over three rivers, one bay, one inland lake, and multiple creeks. The CRCA has jurisdiction over approximately 3,500 square kilometres with a population density of 25 to 100 persons per square kilometre. Therefore, despite not being in Northern Ontario and being located along a coastline, the CRCA is relatively similar to Conservation Sudbury due to population and size and therefore received a context similarity of 7.7/10.

Summary Analysis

The Cataraqui Region Conservation Authority has multiple policies and programs in place which successfully aid in addressing flood risk management and flooding in the region. The first major contribution is the acknowledgement and actions in place to help with participation, engagement and education. The CRCA's *Service Delivery Procedures for Ontario Regulation 148/06* document provides applicants information on the entire application process, checklists, sample site plans, protocols, templates, and inquiry procedures when submitting an application. This allows the general public to have a deeper understanding of how to apply for development within the jurisdiction of a CA.

The CRCA has also successfully implemented programs for tree planting within its jurisdiction to aid in flood risk management. The CRCA has partnered with the neighbouring Rideau Valley Conservation Authority and Government of Ontario to plant 3.4 million trees since 1964. In addition to creating partnerships, the CRCA also has a native species seedling sale at one of their conservation areas in the spring and fall every year. This provides residents with resources to aid in stormwater retention while preserving the natural ecosystem. Through partnerships and the sale of seedlings the CA is able to alleviate cost and generate income while aiding in stormwater retention throughout the numerous watersheds under its jurisdiction.

Lastly, the CRCA has effectively created an *Environmental Planning Policies* document. The policies contained within the this document outline uses, setbacks, site alteration, and other parameters as they relate to flooding hazards. Through creating additional policy documents that work in unison with the main policy document, it strengthens and reinforces the intent of policy directed towards flood risk management.

6.8 SOUTHERN ONTARIO

6.8.1 SOUTHERN ONTARIO SCORE SUMMARY

Table 14: *Summary of Southern Ontario case study scores.*

Flood Risk Management Authority (Context Similarity in Brackets)	**Overall**	**Climate Change**	**Participation Engagement & Education**	**Integrated Flood Risk Management Approaches**	**Policy Delivery & Evaluation**
Southern Ontario	**/40**	**/10**	**/10**	**/10**	**/10**
Essex Region Conservation Authority (6.2)	22.4	9.1	3.8	7.1	2.5
Grand River Conservation Authority (6.6)	34.4	7.7	8.3	9.6	8.8
Long Point Region Conservation Authority (7.7)	19.7	6.8	2.9	6.3	3.8
Maitland Valley Conservation Authority (6.2)	12.6	6.4	0.8	2.9	2.5
Saugeen Valley Conservation Authority (6.9)	23.9	3.6	4.0	7.5	8.8
Upper Thames River Conservation Authority (6.2)	24.1	5.0	2.0	8.3	8.8

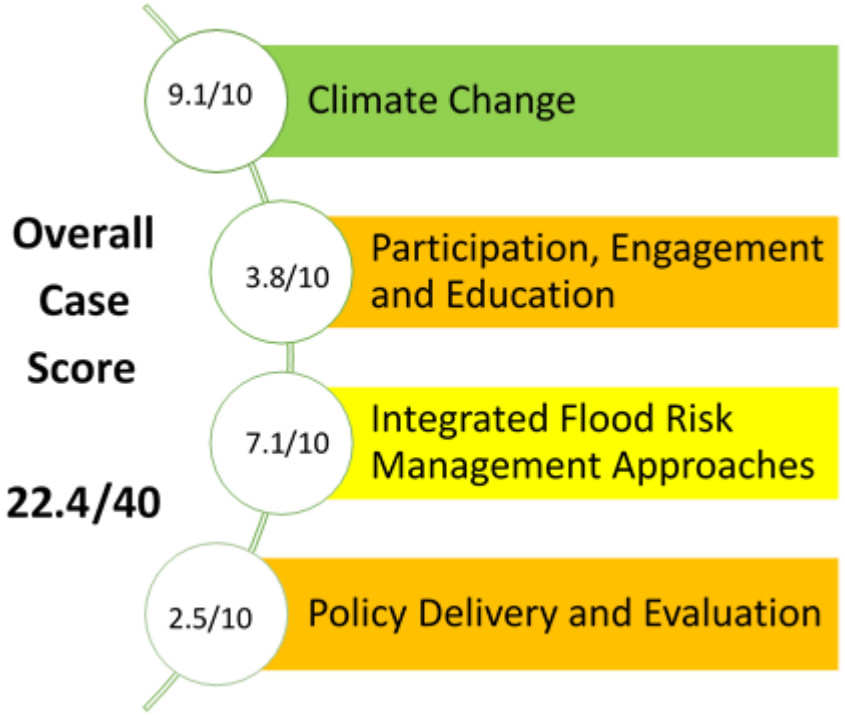
6.8.2 ESSEX REGION CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.2 / 10)

Primary Documents Examined

A Place for Life: Strategic Plan 2016-2025 (2016)
Windsor/Essex Region Stormwater Management Standards Manual (2018)
Big Creek Watershed Plan (2013)
How to Create a Rain Garden: A Guide for Homeowners! (2018)

Key Takeaways

- Low impact development is a land use planning toolkit that can introduce stormwater management to help reduce flood risk.
- Effective stormwater management can make cities more resilient by creating linkages between flooding, biodiversity conservation and climate change interventions.
- Developing partnerships with stakeholders is essential for conservation authorities to implement key policies.
- Providing regulation area mapping in a format that is accessible to the public can help streamline the planning application process.



6.8.2 ESSEX REGION CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.2 / 10)

Introduction

The Essex Region Conservation Authority (ERCA) is the southernmost conservation authority in Ontario, with jurisdiction over the watersheds of the City of Windsor, the seven municipalities of the neighbouring County of Essex, as well as the separated Township of Pelee. This area covers the coastal areas of Lake Erie, the Detroit River, and their tributaries. Although Windsor has a higher population and population density than the City of Sudbury, its neighbouring municipalities are predominantly small agricultural settlements. This area has been particularly affected by flood events in recent years as noted in the Province's 2019 Review of Flood Events (Government of Ontario, 2019). Flooding in this area has been exacerbated by widespread historical biodiversity loss, and relatively impermeable clay soils that prevent water filtration during storm events. Despite these setbacks, ERCA has been able to implement a stormwater management standards manual that will guide all new development in the Windsor-Essex region.

Summary Analysis

The strengths of ERCA's approach to flood management lie in its ability to address climate change and adopt measures consistent with a flood risk management approach. ERCA capitalized on its relationships with its member municipalities to help introduce a stormwater management standards manual for the entire region. This manual now guides all new development in the member municipalities.

ERCA has also created several community green infrastructure programs and has explicitly connected these programs to its efforts to adapt new development to the effects of flooding caused by climate change. ERCA has a naturalization program that, among other things, encourages private landowners to restore wetlands using a combination of public and private grants. ERCA also has a community program that educates private property owners on how to create rain gardens to store stormwater and limit its impact on their property.

Finally, ERCA has a useful GIS mapping tool on its website which overlays the regulatory floodplain on top of municipal parcels so that property owners can quickly verify if their property is within the regulatory floodplain. Such a tool could streamline planning permit applications by allowing the public to verify the applicable regulations to their property before submitting a permit application.

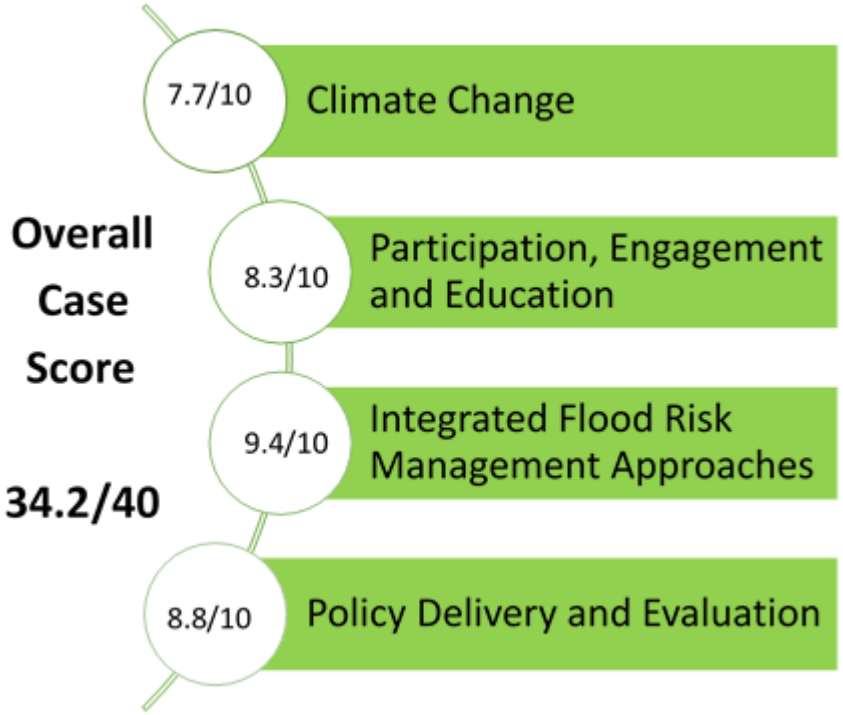
6.8.3 GRAND RIVER CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.6 / 10)

Primary Documents Examined

Grand River Water Management Plan 2014
Grand River Water Management Action Plan 2014-2018
Summary of Accomplishments (June 2019)
Grand River Watershed: State of Water Resources (2020)
Policies for the Administration of the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation

Key Takeaways

- Collaborative project teams and working groups can help instill responsibility and accountability in plan development and execution.
- Community responsibility and investment in flood risk management is improved by dividing larger projects into smaller units such as flood maps, flood action plans, and climate change modelling.
- Developing partnerships with local groups and collaborating towards sustainability and flood management practices is an effective way to outline the role of the CA to the public.
- Updating policy to include regulations specific to factors such as the type of development, the location within the watershed and the level of risk provides a more streamlined and clear development process to the public and other development bodies.



6.8.3 GRAND RIVER CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.6 / 10)

Introduction

The Grand River watershed is the oldest Conservation Authority agency in Canada. It is approximately 6,800 square kilometers is size and holds approximately 985,000 residents across 39 municipalities. Many of the urban centres such as Guelph and Waterloo have a similar downtown density to downtown Sudbury, giving it a context similarity of 6.6/10. Many major rivers within the watershed make flooding and flood risk management a major concern for this area. Upstream events and downstream impacts on flooding are significant and strongly related to the land use management in the region.

Summary Analysis

The first major contribution to addressing flood risk management is the acknowledgement and actions in place to address climate change issues. This includes active programs such as rural water quality programs and wetland restoration grants.

The programs and major plans in place make extensive use of working groups, public input and actions, and Indigenous knowledge to successfully instill ongoing responsibility in the community, government stakeholders, and other community groups. This includes groups within the Watershed Management Plan (WMP) such as a steering committee and project teams. This method of engagement and organization has resulted in policy delivery and evaluation which is accountable and reaches many of the initial goals set out by the WMP and associated documents. The GRCA continually re-evaluates and assess their goals.

Lastly, the GRCA effectively balances the need for development buy using land use tools and regulations to address flood risk management. Although dams and reservoirs are used to address flooding, the GRCA notes their limitations and has decommissioned some to restore the natural habitat. The most notable GRCA policy document is *the Policies for the Administration of the Development, Interference with Wetland and Alterations to Shorelines and Watercourses Regulation (2015)*. This document outlines development policies in flood hazard zones and specific areas within these zones based on land use, human habitability, and region-specific elements such as stormwater management facilities, isolated water bodies, docks and piers, and riverines. The detail of these policies can help aid in streamlining questions and confusion around development allowances for different areas and types of development within a conservation authorities jurisdiction.

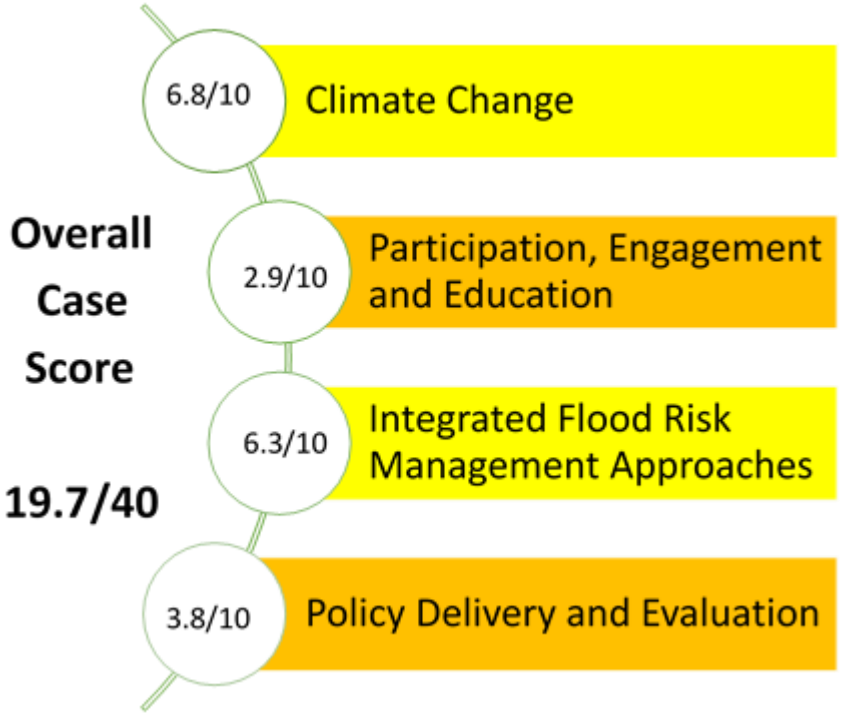
6.8.4 LONG POINT REGION CONSERVATION AUTHORITY (CONTEXT SIMILARITY 7.7 / 10)

Primary Documents Examined

Strategic Plan 2019-2023
Policies for the Administration of the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation (2017)
LPRCA Low Impact Development Demonstration Project
LPRCA Watershed Report Card (2018)

Key Takeaways

- Updating local regulatory policy for development in the floodplain presents opportunity to include detail for specific land uses such as residential, commercial, public infrastructure, and wetlands.
- Using community members as the face of public programs can aid in community engagement in watershed programs.
- Showcasing LID through CA initiated projects and interactive learning centres on CA lands aids in acceptance and implementation of these programs in communities.



6.8.4 LONG POINT REGION CONSERVATION AUTHORITY (CONTEXT SIMILARITY 7.7 / 10)

Introduction

The Long Point watershed covers approximately 2,900 square kilometres of both urban and rural land in South-Western Ontario. The total population and density are similar to Conservation Sudbury's jurisdiction, giving it a context score of 7.7/10. The watershed incorporates 6 subwatersheds. Within these watersheds the major communities include Tillsonburg, Simcoe, Port Dover, Norwich, Port Burwell, and others. An intrinsic network of rivers and streams and the associated impacts from shoreline flooding create significant flood issues for the Long Point Region and associated communities.

Summary Analysis

The LPRCA has multiple examples of climate change and flood risk management projects and practices within LID development and associated programs. A noteworthy example is the 2010 LID project in which the LPRCA created an education site for LID methods such as bioswales and reduced paving on newly purchased LPRCA lands. This project partnered with local community groups, business investors, and schools such as the local Tillsonberg High School to build a site for the public to learn about innovative development approaches within the watershed. These create lasting relationships which can be extremely useful for future development and planning projects that require community involvement for success and affordability (ie tree planting programs with volunteers).

The second noteworthy aspect of the LPRCA is the updated *Policies for the Administration of the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation,* updated as recently as 2017. This document contains general development policies for flood hazard areas, as well as policies for specific land uses within these areas such as residential, commercial, public infrastructure, and wetland developments. Conservation Sudbury could adopt similar practices when updating its Development and Interference policies. This granular approach sets specific and easily accessible guidelines for development and may provide greater guidance for the public to understand how regulations are applied in the floodplain.

The overall LPRCA communication and engagement strategy could be significantly improved. Information about public consultation and flood risk management projects and programs is not readily available. Some projects are stated, however details about follow up methods or action plans are lacking.

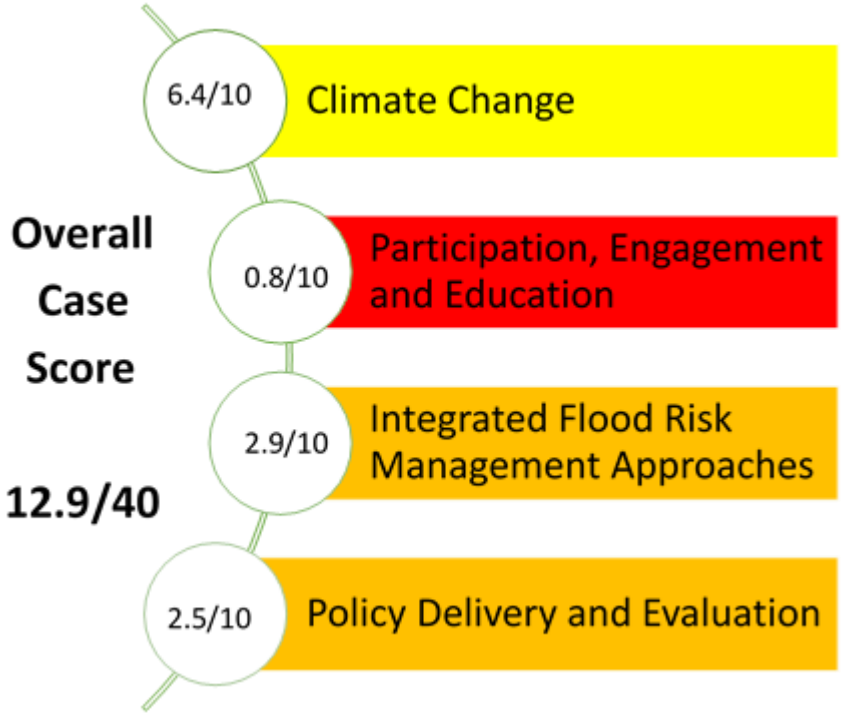
6.8.5 MAITLAND VALLEY CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.2 / 10)

Primary Documents Examined

Maitland Valley Conservation Authority: Policies and Procedures for Compliance with the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation
Carbon Footprint Initiative Framework
Climate Change Background Report

Key Takeaways

- Establishing a not-for-profit carbon/climate change initiative with public and private entities has been key to raising money and garnering public support for rehabilitation, restoration, and natural infrastructure projects.
- The role of the conservation authority, as well as their relationship with other governing bodies should be stated clearly, rather than implied, by providing the legislative framework that they work within.



6.8.5 MAITLAND VALLEY CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.2 / 10)

Introduction

The Maitland Valley Conservation Authority (MVCA) is in Southern Ontario, and serves a population of roughly 63,307 residents, with a population density of 18 persons/km2. The MVCA covers the watersheds of the Maitland, Nine Mile and Eighteen Mile Rivers, as well as smaller watersheds along the Lake Huron Shoreline. Unlike Sudbury, the MVCA lands are mostly agricultural, and the conservation area does not include a large urban centre. Further, the MVCA regulates the shoreline of North Huron, which is reflected in its policies and procedures as they include many regulations for coastal hazards. The MVCA scored 6.2 in context similarity to Conservation Sudbury, with their largest similarity being that they share the same Köppen climate category.

Summary Analysis

The Maitland Valley Conservation Authority scored well in the climate change category. The Authority has established many successful community projects through *their Carbon Footprint Initiative Leadership Team (CFI)*. The CFI is a not-for-profit alliance for public and private entities. The Team takes steps to reduce their carbon footprint and supports many initiatives including rehabilitation and restoration projects. One of these projects, The Middle Maitland Headwaters Restoration Project, restored approximately 300 acres of floodplain and river valley lands, transforming them into a natural buffer for the Middle Maitland River. This achievement is remarkable considering the small population of the watershed area, especially as it does not comprise of a large centre, which exemplifies the benefit of having the initiative.

The CFI has also launched several natural infrastructure projects including rural stormwater management systems to control gully erosion, and the use of berms, wetlands, and grassed waterways in stormwater management. Establishing a similar initiative with private and public partners may be a feasible way for Conservation Sudbury to undertake rehabilitation, restoration, and natural infrastructure projects.

The *Maitland Valley Conservation Authority: Policies and Procedures for Compliance with the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation* is a bare-boned policy document, covering only the essential elements of their regulations. There are many shortcomings of the policy, with a main one being that the role of the MVCA, as well as their relationship with other governing bodies is not clearly stated, but left for readers to imply by providing the legislative framework that they work within. This shortcoming was chosen as a key takeaway for this case study because staff at Conservation Sudbury have emphasized the importance of the public knowing their role and responsibilities.

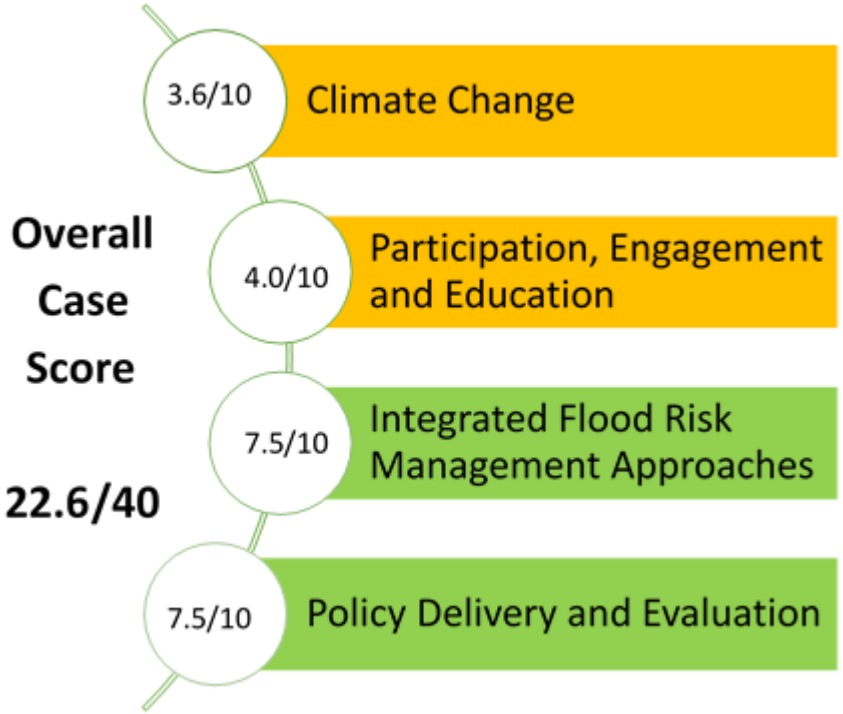
6.8.6 SAUGEEN VALLEY CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.9 / 10)

Primary Documents Examined

Environmental Planning and Regulations Policies Manual
Forest Management Plan
Strategic Plan

Key Takeaways

- A Natural Heritage Systems Approach to Environmental Planning allows the Conservation Authority to protect the ecological integrity of the watershed as a whole and consider cumulative effects.
- The consolidation of all policies in a new environmental planning and regulations manual has benefits to SVCA staff, municipalities, the development community, community stakeholders, and provincial partners as only one document has to be reviewed when submitting applications.



6.8.6 SAUGEEN VALLEY CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.9 / 10)

Introduction

Saugeen Valley Conservation Authority (SVCA) is located in Southern Ontario. It covers approximately 4657 square kilometres with a population of approximately 90,000. There are three major watersheds that the SVCA has jurisdiction over, and a series of sub-watersheds. Unlike Sudbury, the SVCA lands are mostly agricultural and rural, and the conservation area does not comprise of a large urban centre. Further, the SVCA regulates the shoreline of Lake Huron, which is reflected in its policies and procedures as they include many regulations for coastal hazards. Therefore, the SVCA scored 6.9 in context similarity compared to Conservation Sudbury.

Summary Analysis

The SVCA *Environmental Planning and Regulations Policies Manual* states that a watershed scale perspective must be maintained and so any decisions made must consider cumulative impacts on the watershed as a whole. Planning on a watershed scale is supported by A Natural Heritage Systems (NHS) Approach to Environmental Planning, which is adopted by the SVCA. It is recognized by the SVCA that important ecological linkages extent beyond property, planning areas, and political boundaries. The SVCA uses the *Provincial Policy Statement* as a tool when defending the Natural Heritage Systems Approach as the PPS states that:

> The diversity and connectivity of natural features in an area, and the long-term ecological function and biodiversity of natural heritage systems, should be maintained, restored or, where possible, improved, recognizing linkages between and among natural heritage features and areas, surface water features and ground water features.

The role and responsibility of the SVCA is clearly stated in the *Environmental Planning and Regulations Policies Manual*. While the policy does not have a timeline to evaluate goals, the SVCA has a Strategic Plan that compliments this policy. In the *Strategic Plan*, goals related to flood risk management are outlined and timing is laid out, with detailed actions they wish to achieve that act as measurable criteria.

A strength of the SVCA is that all the policies have been consolidated in a new environmental planning and regulations manual. This manual serves many users including SVCA staff, municipalities, development community, community stakeholders, and provincial partners.

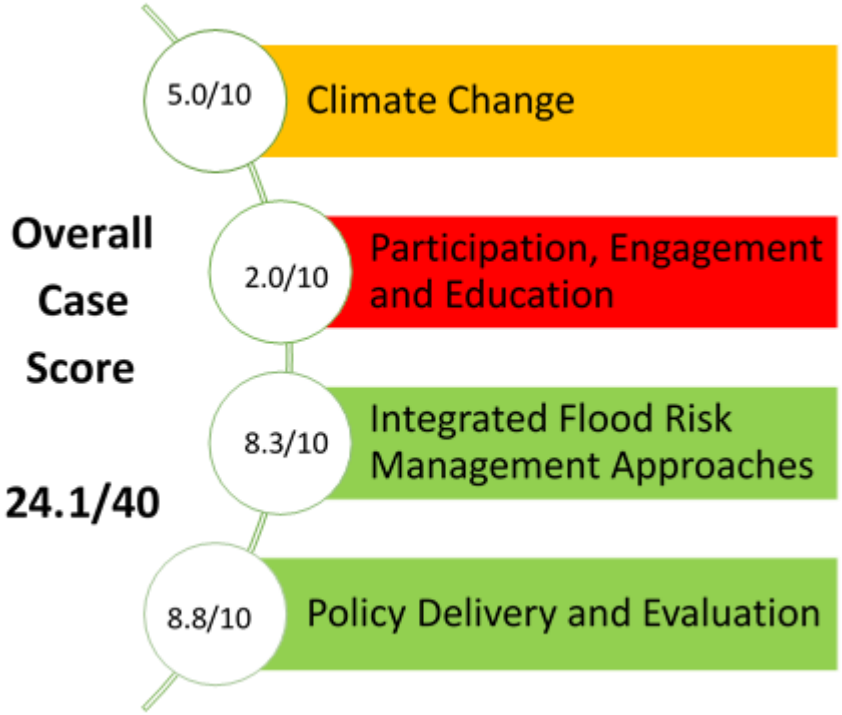
6.8.7 UPPER THAMES RIVER CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.2 / 10)

Primary Documents Examined

Environmental Planning Policy Manual for the Upper Thames River Conservation Authority
Strategic Plan June 2016
Stormwater Low Impact Development (LID) webpage

Key Takeaways

- Stormwater Low Impact Development programs to utilize natural stormwater management practices are an effective strategy to educate about and implement LID practices.
- Adopting a Natural Heritage Systems Approach to defend the consideration of cumulative impacts on the watershed when making decisions is an approach encouraged in the PPS and successful in this example.
- Preparing one Environmental Planning Policy Manual to facilitate an integrated systems approach for watershed planning creates a more clear and comprehensive planning process.



6.8.7 UPPER THAMES RIVER CONSERVATION AUTHORITY (CONTEXT SIMILARITY 6.2 / 10)

Introduction

The Upper Thames River Conservation Authority (UTRCA) was formed in 1947 and covers the upper watershed of the Thames River. The landscape of the watershed is mainly rural, but also comprises the large urban centres of London, Stratford, and Woodstock. While the UTRCA is in Southern Ontario and serves a higher population than Conservation Sudbury, its watershed is located inland and is in the same Köppen climate category. For this reason, the context similarity score for the Upper Thames River Conservation Authority is 6.2/10.

Summary Analysis

The Upper Thames River Conservation Authority has various initiatives that help mitigate the effects of climate change. A program that could be adopted by Conservation Sudbury is a *Stormwater Low Impact Development (LID) Program*. With the help of community partners, the UTRCA has begun an LID program, hosted training opportunities and events related to LID, and has been involved in nine LID projects.

The UTRCA also includes policy for locally significant wetlands as an effective way of protecting all wetlands and not just those that are provincially significant. This may be a way for

While the locally significant wetlands do not have the same type of protection as provincially significant wetlands, the UTRCA does encourage local governments to protect them.

Adopting a Natural Heritage Systems (NHS) approach, which is recognized by the PPS, allows the Authority to consider cumulative impacts of decisions. Further, it allows the Authority to encourage member municipalities to prepare comprehensive studies on natural hazard, natural heritage, and natural resource features when making land use planning decisions. This may not be economically feasible or practical for every planning decision, as recognized by the UTRCA. A solution to this is that studies be conducted in areas where there is more development pressure, or where resources are stressed.

Lastly, having one comprehensive manual is beneficial as it facilitates an integrated systems approach for watershed planning. The use of a Strategic Plan with environmental-based targets is also something which is worth considering in policy development. The UTRCA has an *Environmental Targets: Strategic Plan* that was created in June 2016. The plan includes targets to improve subwatershed health, restore natural vegetation cover, reduce flood and erosion, and support green infrastructure. The Strategic Plan should also include potential partners for each target.

6.9 NATIONAL AND INTERNATIONAL

6.9.1 NATIONAL AND INTERNATIONAL SCORE SUMMARY

Table 15: *Summary of Provincial and International case study scores.*

Flood Risk Management Authority (Context Similarity in Brackets)	**Overall**	**Climate Change**	**Participation Engagement & Education**	**Integrated Flood Risk Management Approaches**	**Policy Delivery & Evaluation**
Other Provinces	**/40**	**/10**	**/10**	**/10**	**/10**
Prince George, BC (6.9)	16.2	6.4	2.8	4.6	2.5
International					
Southern Tier Central Region of New York (7.7)	12.7	2.3	0	5.4	5

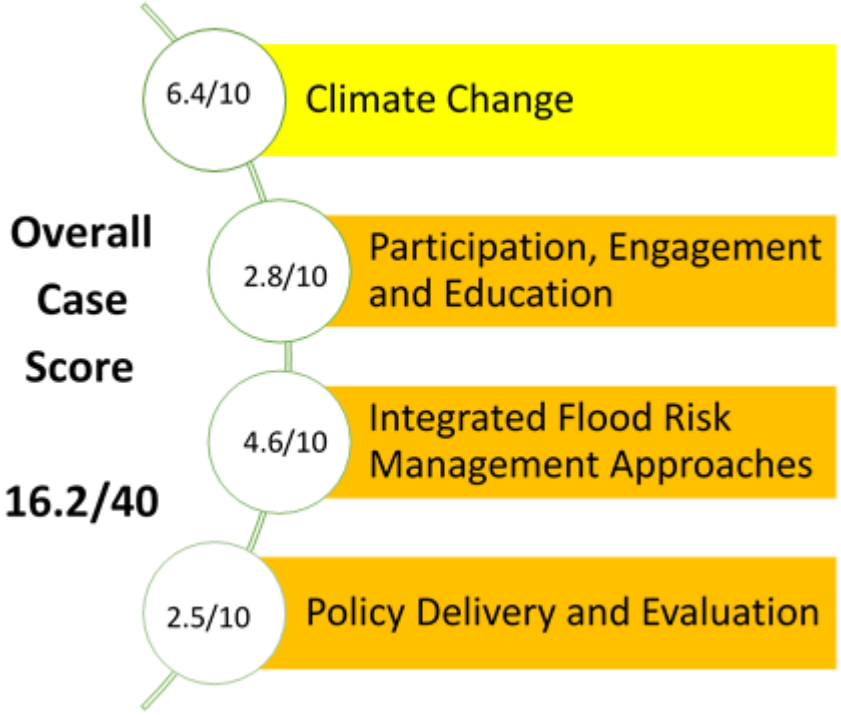
6.9.2 CITY OF PRINCE GEORGE, BC (CONTEXT SIMILARITY 6.9 / 10)

Primary Documents Examined

City of Prince George Bylaw NO. 8285 A bylaw of the City of Prince George to designate land as flood plain and regulate the development of land that is subject to flooding (2011)
Prince George Official Community Plan (2012)
Flood Risk Evaluation and Flood Control Solutions Phase 2 Final Report (2009)
2020 Climate Change Mitigation Strategy (2020)
The Hudson's Bay Wetland Project (2020)
Mapping Resource – PGMAP (2020)

Key Takeaways

- Wetland restoration and improvement can be completed for a minimal cost if a willing community partner can be found to undertake the work.
- Having a robust and transparent public consultation process can assist in improving public support for flood control actions.
- Creating a single flood risk management document is a significant tool which can aid in guiding flood risk management in the future.



6.9.2 CITY OF PRINCE GEORGE, BC (CONTEXT SIMILARITY 6.9 / 10)

Introduction

The City is located at the junction of the Fraser and Nechako Rivers, and is therefore very susceptible to flooding. In response to a significant flood event in 2007, the City initiated a two-phase flood risk management study and have been acting on the recommendations of that report since 2010. Prince George has a population of approximately 74,000 people. The municipality jurisdiction covers an area of 318 square kilometres with an average population density of 233 people per square kilometre. It is in the same general climatic zone as Conservation Sudbury and is inland.

Summary Analysis

The City of Prince George has several key initiatives to manage flood risk. Based on recommendations from the 2010 study they have constructed several flood infrastructure improvements such as dikes and natural back channels. In addition to these structural measures, land use changes have occurred through purchasing properties in high flood risk areas. Due to the costs associated with enacting these policies the City of Prince George needed to gain significant public support.

Public participation and consultation were documented effectively in the *Flood Risk Evaluation and Flood Control Solutions Phase 2 Final Report.* Meetings were held over a two-day conference where any member of the public could contribute. The public was given information collected in the first phase of the flood risk study. The first phase report identified areas with significant flood hazards, the primary causes of flooding, and methods to address flood risk. The advantages and disadvantages of several methods were discussed and the public participants were given the opportunity to ask questions and voice their concerns.

Addressing climate change was a significant strength for Prince George due to *its 2020 Climate Change Mitigation Strategy*. Its *Official Community Plan* emphasizes the need for natural stormwater management practices. Work is underway to integrate natural approaches into the city's stormwater management bylaw. One area of great significance for Prince George was in the protection and restoration of wetlands. Prince George has an ongoing wetland restoration project in partnership with a local community group. The Hudson's Bay Wetland Project restores and manages a large wetland area within the City's boundaries.

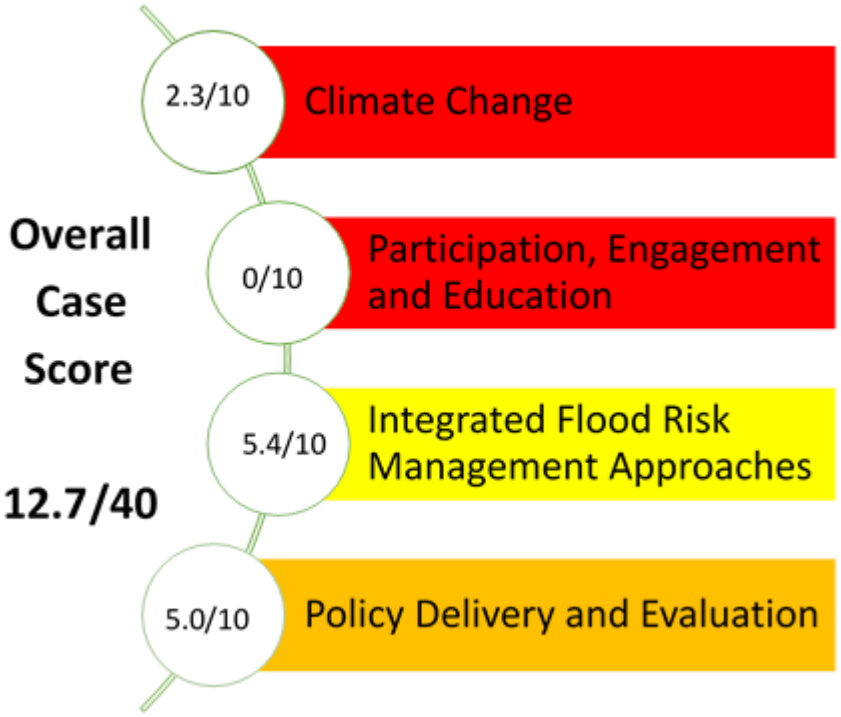
6.9.3 SOUTHERN TIER CENTRAL REGION OF NEW YORK (CONTEXT SIMILARITY 7.7 / 10)

Primary Documents Examined

Municipal Land Use Strategies for Improving Flood Resilience
Protecting Your Home and Property from Flood Damage
Mitigation Ideas for Reducing Flood Loss

Key Takeaways

- Encouraging the use of natural stormwater management approaches such as bioswales, rain gardens, and green roofs are effective and simple tools for flood risk management.
- Federal guiding documents can be successfully integrated and used within local flood risk management practices such as mapping and land use development.
- The use of a hierarchical flood lines based on type of facilities is a useful way to create more stringent uses in high risk areas (i.e. a 500-year flood line for critical facilities such as jails, hospitals, schools, daycare facilities, public and private utilities, fire stations, emergency operation centers, police facilities, etc.).



6.9.3 SOUTHERN TIER CENTRAL REGION OF NEW YORK (CONTEXT SIMILARITY 7.7/ 10)

Introduction

The Southern Tier Central Region Development Board is a land development board located in South Central New York and is in the same climatic zone as Conservation Sudbury. It is comprised of Chemung, Schuyler, and Steuben Counties. The STCR is similar to Conservation Sudbury being located inland and therefore not handling coastal flooding. However, being an example from the United States, the development board operates under different rules and regulations than Conservation Sudbury which is acknowledged throughout this analysis. The STCR is covers approximately 5,585 square kilometres with a population of 197,747 residents. Based on these factors it received a context similarity score of 7.7/10.

Summary Analysis

The STCR has multiple policies and programs in place which successfully aided in addressing flood risk management and flooding in the region. The first major contribution to addressing flood risk management is the *Municipal Land Use Strategies for Improving Flood Resilience* document which encourages natural stormwater management approaches such as bioswales, rain gardens and green roofs. While the STCR cannot regulate the zoning of land, section 13 of this document notes the need for land uses in the region to utilize these design strategies. The encouragement of such designs is a key takeaway from the STCR because despite not having the regulatory power to zone for land uses, the regions development board provides natural approaches to limit the volume of stormwater entering the natural systems in a storm event.

The STCR outlines design guidelines for how to flood proof one's home and property. Design guidelines are useful for two reasons. One, design guidelines have the ability to be regulatory if they work in conjunction with development policies adjacent to the floodway. Second, it provides a list of regulations which educates the public while also allowing the individual to flood proof their own home and property, protecting themselves and their family.

Finally, the STCR uses a 500-year flood line for critical facilities. A 500-year flood line is derived from a 500-year flood which has a 0.2% probability compared to a 100-year flood which has a 1% probability. While it is understood that critical facilities as described by the STCR would typically fall outside of Conservation Sudbury's scope of power, the utilization of a 500-year flood line is a potential tool to further limit hazardous development within a floodplain.

CHAPTER SEVEN

FINAL RECOMMENDATIONS

7.0 Final Recommendations

The following section will recommend possible next steps for Conservation Sudbury to build upon and utilize to update existing flood hazard policies. These recommendations are based upon the background research and case studies contained within this report. Please refer to Appendix 2 for the full details on the example authorities provided with the recommendations below.

It is recognized that Conservation Sudbury and the City of Greater Sudbury may already be implementing some of these recommendations in part. Where this is the case, it is the intention of the recommendation to encourage the continuation of these activities. To assist with implementation of these recommendations, a potential strategy has been provided that includes approximate importance, timeline for completion and cost. This strategy is shown in Table 16.

The four major categories used to evaluate the case studies aided in highlighting areas where Conservation Sudbury may be able to learn from and follow the lead of other authorities. It was the intention that the recommendations would also fall into these four major categories (i.e. Climate Change; Participation, Engagement and Education; Integrated Flood Risk Management Approaches; and Policy Delivery and Evaluation), however, once the recommendations were developed, it was apparent that this was not the most effective way to categorize them as many recommendations fell into multiple categories. Therefore, categories that better reflect the nature of the recommendations were deduced, resulting in the formation of the four final recommendation categories below.

The background research identified that the most significant change to the natural hazards policy context in Ontario is the requirement for planning authorities to prepare for the impacts of a changing climate that may increase the risk associated with natural hazards. This report relied on an Integrated Flood Management framework to understand the connection between climate change and flooding and to determine how Conservation Sudbury should respond to this risk. The benefit of an Integrated Flood Management approach is twofold. It acknowledges that flood events are influenced by the interconnection of entire watersheds with surrounding land uses; and it acknowledges that because of this interconnection, a hazards-based approach that relies entirely on locating development outside of the floodplain is insufficient and should be supplemented by a risk-based approach to managing development in and around the floodplain.

The lens used throughout this report was also influenced by a concern that the public frequently misunderstands the purpose and role of Conservation Sudbury. In order to address this misunderstanding, this report emphasized approaches to flood risk management which involve local stakeholders, continuously inform the public about Conservation Sudbury's activities, and educate the public about the importance of conservation authorities by focusing on their core mandate to protect people and property from flooding.

Based on these assumptions, and through application of evidence gathered from the activities of other conservation authorities and flood management authorities, this report makes the following recommendations:

A. Integrated Watershed Management Plan

The recommendations provided under Integrated Watershed Management follow the key takeaways found within the case study evaluations completed. These recommendations are meant to encourage Conservation Sudbury to take more of a proactive approach to land use planning and flood risk management as opposed to a reactive infrastructure-based approach; with climate change a proactive, risk-based approach is vital for protecting people and property. A comprehensive flood risk management plan containing all policies on flooding, such as an Integrated Watershed Management Plan or equivalent, would help Conservation Sudbury operate this way. Conservation authorities are increasingly adopting a low impact approach to development. Incorporating LID in policy will place more responsibility on the development community to mitigate flood risk. Further, these recommendations ask Conservation Sudbury to recognize the value of natural infrastructure and ecosystem services for flood protection.

A-1 Create an Integrated Watershed Management Plan or equivalent planning document that includes all flooding policies (Example: Otonabee).

A-2 Incorporate Low Impact Development (LID) into the comprehensive flood management document. Stormwater submissions shall demonstrate that every possible effort has been made to follow the LID approach (Example: Lake Simcoe Region).

A-3 Recognize the importance of wetlands in protecting people and property from flooding in policy (Examples: Grand River; Nottawasaga Valley).

A-4 Adopt a climate change lens in policy to link stewardship and other activities to flood impacts (Examples: Essex Region; Kawartha).

A-5 Prioritize stewardship programs that relate to core mandate (i.e. wetland restoration and re-naturalization of shorelines, riverbanks and valleys) (Example: Maitland Valley).

A-6 Use an evidence-based approach to update flood-related policies, and document the process for public record (Example: Grand River).

A-7 Investigate funding opportunities and new technologies (LIDAR) that make updating regulatory mapping possible.

- This could include hiring a summer student from a post-secondary remote sensing program to assist with mapping completion.

A-8 Require that an agreement be placed on the title of a property for any approvals under Ontario Regulation 156/06 so that future property owners know there are restrictions in place (Example: Mattagami Region).

B. Stakeholder Engagement Framework

The primary goal of this research was to identify pragmatic solutions for Conservation Sudbury to implement regarding land use planning and flood risk management. The research conducted on Conservation Sudbury and other conservation authorities in Ontario shows that many conservation authorities have filled resource gaps through partnerships. Additionally, the importance of planning at the watershed scale has been emphasized, however, Conservation Sudbury's regulatory environment is not conducive to this as their jurisdiction does not cover the full watersheds. Therefore, recommendations have been included that attempt to bring other stakeholders together with a focus on other regulatory bodies, for a more holistic approach.

B-1 Identify stakeholders for potential partnerships, identify strengths, communicate roles, and collaborate:

- Universities and colleges can support watershed research.
- High school and elementary school students can be involved in education and volunteer opportunities.
- Municipalities can assist through resource and cost sharing on larger projects, such as updating mapping or developing new policy.

- NGO's can be used for watershed-based stewardship initiatives (Example: Friends of Lake Laurentian).
- Businesses can sponsor stewardship activities or be leaders in low impact development.
- Private landowners can adopt natural stormwater management practices on their property and participate in volunteer initiatives.

B-2 Consider forming a watershed subcommittee with representation from all affected stakeholders (including all government agencies and First Nations) within the watershed for the purpose of information sharing and collaboration on water-related issues such as flooding (Examples: Grand River; South Nation). May consist of:

- Clearly communicating roles and responsibilities
- Establishing regular meetings/conference calls
- Documentation of activities – publicly accessible
- Recognizing the value of Traditional Ecological Knowledge

B-3 Use Conservation Sudbury's commenting role and relationship with the City of Greater Sudbury to make local flood policies more robust by ensuring that the *Official Plan* and Zoning By-Law are consistent with future Conservation Sudbury policies.

B-4 Collaborate with the City of Sudbury and recommend adopting a climate change strategy/ action plan to coordinate land use policies.

C. Website Design and Public Engagement

As previously stated, staff from Conservation Sudbury have expressed that their role is not always clearly understood by the public. While these recommendations are not direct recommendations for land use planning, they have been included as they ultimately affect the day-to-day implementation of land use planning. The public, especially landowners, play a major role in flood risk management and for landowners to be successfully included in this process, they need easy access to the right information.

C-1 Make all non-confidential flood management policies/documents publicly available through an online resource library on the Conservation Sudbury website.

C-2 Document activities and make these documents accessible and understandable to the public.

C-3 Use local examples in policy communication (Example: Lake Simcoe Region).

C-4 Improve publicly available mapping on website (Example: Grand River).

- Public should be able to look up applicable regulations on their property (Example: Essex Region).
- In addition, improved mapping could be unlocked on CAmaps (Examples: Kawartha; Mississippi Valley).

C-5 Make the application process clear and transparent for the public using resources explaining how development applications are processed and evaluated.

- Provide an annotated application form.
- Provide a checklist with required information and documents.

C-6 Provide information on Conservation Sudbury's website for utilizing on-site stormwater management techniques such as rain barrels, raingardens, and permeable driveways (Examples: Essex Region; Kawartha).

C-7 Include a section on Conservation Sudbury's website that explicitly makes the connection between land use planning and flooding and provides all the resources the public would need.

D. Monitoring and Evaluation

Lastly, the recommendations provided under monitoring and evaluation were chosen as these additions have potential to assist Conservation Sudbury in prioritizing and accomplishing their action items, as well as clearly communicate to their stakeholders the work the Authority is doing.

D-1 Publish an annual program review that covers what the Authority has accomplished in the previous year as well as what the goals are for the coming year (Example: Nottawasaga Valley).

D-2 Include measurable deliverables and specific timelines in future strategic plans to track progress towards action items (Example: Lake Simcoe Region).

Table 16: *Approximate implementation strategy for recommendations.*

Recommendation Number	Importance			Timeline For Completion			Cost		
	High	Medium	Low	Long Term	Medium Term	Short Term	High	Low	Little to None
Integrated Watershed Management Plan									
A-1									
A-2									
A-3									
A-4									
A-5									
A-6									
A-7									
A-8									
Stakeholder Engagement Framework									
B-1									
B-2									
B-3									
B-4									
Website Design and Public Engagement									
C-1									
C-2									
C-3									
C-4									
C-5									
C-6									
C-7									
Monitoring and Evaluation									
D-1									
D-2									

CHAPTER EIGHT

CONCLUSION

8.0 Conclusion

The initial vision of this report was to create a document which would provide evidence-based land use practices that would aid in mitigating the effects of future flood events which have been exacerbated by climate change in the watersheds regulated by Conservation Sudbury. These evidence-based practices were formulated as a set of final recommendations in this report which were intended to act as a baseline study for Conservation Sudbury to utilize in future flood risk policy and plan development.

Overall, the use of an evidence-based approach was successfully integrated into the report through multiple iterations of criteria development, which resulted in an analysis grounded in current and relevant flood risk management theories and land use planning concepts. The application of global climate change goals, current local and provincial policy, and Integrated Flood Management theories within the analysis allowed for conclusions which were grounded in previously justified policies and theories. The application of land use planning as a method to flood risk management was embedded in the entirety of the analysis and final recommendations through a review of land use theory which was justified by current day land use flood management approaches. Utilizing proposed theories and research which was then justified in current day case studies and successes further shows that the final recommendations are not only based on land use theory but grounded in real life examples which provide evidence of the success of these theories.

The guiding principles of this report included items relating to climate change, effective and inclusive consultation, risk-based flood management approaches, and consideration for local contexts. These guiding principles were incorporated within the case study analysis criteria and therefore strongly embedded within the final recommendations. The consideration of local context in Sudbury was utilized to select case studies to be analyzed, and as such was the first major decision which further guided the analysis. Climate change and the recognition, adaptation, and mitigation measures associated with it were utilized as one of the major categories for analysis and extraction of best land use planning practices. Furthermore, risk-based flood management approaches were made a focus when analyzing cases and developing recommendations. This included the direct incorporation of Integrated Flood Management principles relating to land uses, watershed scale practices, and both structural and non-structural approaches to flood management. Lastly, the

principle of inclusive and meaningful consultation was used to stringently determine what consultation was meaningful by analyzing strategies which consciously made efforts to incorporate all stakeholders and appropriate groups on an ongoing basis.

Overall, the final recommendations were summarized to inform future policy making in the areas of Integrated Watershed Management Plans, Stakeholder Engagement Frameworks, Website Design and Public Engagement, and Monitoring and Evaluation. These major areas of policy development were deemed as integral parts of the analysis and are a direct result of the evidence-based approach and guiding principles defined at the beginning of this report.

Moving forward the tailoring and/or expansion of this report and its associated information to be adopted within or justify policy shall be of the best interest and use to Conservation Sudbury. Based on the research, analysis, and recommendations made in this report, it is concluded that this information appropriately meets the expectations to be utilized by Conservation Sudbury as a baseline to inform future policy development in relation to flood risk management and land use planning.

GLOSSARY

Term	Definition
100-year Flood Line	The flood line of a flood that has a 1 in 100 chance of being equaled or exceed in any one year.
Catchment Area	The area from which rainfall flows into a river, lake, or reservoir. Also referred to as a watershed or drainage basin.
Climate change	A long-term change in the average weather patterns that have come to define Earth's local, regional and global climates. It has a broad range of impacts and effects to communities, countries, and the world (NASA, 2020).
Conservation Authority	Local watershed management agencies that deliver services and programs to protect and manage impacts on water and other natural resources in partnership with all levels of government, landowners, and many other organizations.
Conservation Sudbury	Conservation Sudbury is one of Ontario's 36 community based watershed stewardship agencies. They oversee and manage interaction between the watersheds, natural environment, local communities, people, and the economy.
Crown Lands	Land owned by the Provincial or Federal Government.
Erosion	The process in which earth materials such as soil or rock are worn away and transported by natural forces such as wind or water flow.
Flood Fringe	The outer portion of the flood plain between the floodway and the extent of the flooding hazard
Flood Fringe Overlay	An area designated within the City of Greater Sudbury Zoning By-law identifying areas of a floodplain in which new development can occur, provided applicable permits are acquired.
Flood risk management	The direct efforts within a community or region to prevent, reduce or eliminate the risk and impacts of flooding events.
Flooding	The coverage or submerging of normally dry land with a large amount of water. Often caused by an overflow of water bodies onto adjacent shorelines and parcels of land due to excessive precipitation or water flow.
Flooding Hazard	The inundation of areas adjacent to a shoreline or a river or stream system and not ordinarily covered by water.

Floodplain	The area, usually low lands adjoining a watercourse, which has been or may be subject to flooding hazards for river, stream and small inland lake systems.
Floodplain Overlay	An area designated within the City of Greater Sudbury Zoning By-law identifying areas of a floodplain in which no new development may occur, and only legally existing buildings and structures are permitted
Floodway	The portion of the flood plain where development and site alteration would cause a danger to public health and safety or property damage. This varies depending on one-zone and two-zone floodplains
Green Infrastructure	An approach to managing wet weather impacts that utilizes vegetation, soil, and other elements to natural processes that manage water and contribute to healthier urban environments.
Hazard Lands	Lands that could be unsafe for development due to naturally occurring processes.
High Water Mark	The highest point a body of water produces in non-flood conditions
Integrated flood management (IFM)	A framework that combines both land and water management, and aims at maximizing the efficient use of floodplains, while simultaneously minimizing the loss of life and property.
Land use planning	The management of land and resources through management of growth and development that addresses social, environmental, and economic issues. Established at provincial level through The *Planning Act, Provincial Policy Statement*, and other special provincial plans, and executed and implemented by municipalities at the local level.
Legal non-conforming uses	Occurs when the use of one's land, building, or structure is not permitted by current zoning by-law but was permitted by a previous by-law.
Low Impact Development (LID)	Systems or practices that use or mimic natural processes that result in greater infiltration or reuse of stormwater to protect water quality and associated surrounding lands.
Non-conforming uses	Occurs when the use of land, a building, or a structure does not meet current by-law requirements and does not meet the requirements of a legal non-conforming use (ie. a new building constructed in a hazard zone or for a use not currently designated by the zoning by-law)
One-Zone Concept	The lands delineated on maps within the regulatory flood lines or those lands required to carry and discharge the flood water or the flood flow of the regulatory flood are the flood hazard areas considered within the limits of the one-zone concept. Within this zone all uses not allowed as Permitted Uses or permissible as Special Uses shall be prohibited.

Regulatory Flood Line	The approved standard used in a particular watershed to define the limit of the flood plain for regulatory purposes.
Regulatory Limit	The geographic extent to which a governing body carries authority to enact policies and regulations.
Riparian Land	The area existing between land and a river or stream that forms a corridor which often provides rich soils where diverse plant species can grow.
Risk based approaches	An approach to problem solving in which stakeholders and policy implementors understand the risks which they are exposed to in a certain situation and apply measure using specific methods and to certain extents which ensure mitigation of the identified risk.
Socio-economic Conditions	Conditions relating to or involving a combination of social and economic factors.
Source Water	Lakes, rivers, aquifers, streams, and reservoirs which provide resources for drinking water supplies.
Structural Interventions	Flood management measures taken to protect people and property from damages due to flooding. Includes structures such as dikes, dams, levees, and engineered channels.
Surface Runoff	Water from rain, snowmelt, or other sources that flows over land surfaces prior to infiltration or reaching a channel or point of low elevation.
Two-Zone Concept	The approach whereby certain areas of the flood plain are considered to be less hazardous than others such that development potentially could safely occur. Separated between the Flood Fringe and Floodway
Urbanization	The process by which large populations concentrate in small geographic areas or the number of individuals in a certain area increases significantly. This often results in increased impermeable surfaces and consequent increased runoff and urban flooding.
Water Cycle	The circulation of water in the Earth's atmospheric system including movement on, above, and below the Earths surface in the forms of liquid, solid, and gas. Also referred to as the hydrological cycle.
Waterbody	A large area of accumulated water generally considered as a bay, lake, river, watercourse or canal, but excluding a drainage channel or irrigation ponds.
Watershed	An area that is drained by a river and its tributaries.
Waterways	An area which contains a natural drainage channel that contains water either permanently or intermittently.

Wetlands	Areas that have been soaked with water long enough for the soil to become waterlogged.
Zoning By-Law	A regulation which controls the use of land in a community. It often outlines lot uses, permitted building uses and layouts, as well as lot dimensions and sizing requirements. Zoning by-laws are complimentary to the Official Plan of a municipality and provide support for meeting the goals of the OP.
POLICY	
Conservation Authorities Act	The *Conservation Authorities Act* is Provincial Legislation enacted in 1946 to ensure adequate responsibility was being taken in regards to conservation and restoration of hydrological features such as water resources and management. The CAA identifies 36 Authorities in Ontario which cover specific geographic regions.
Official Plan	An Official Plan (OP) is a policy document that guides short and long-term development within a community. This is used to guide all other policy and documents in a municipality to reach specific targets relating to employment, housing, transportation, development, and other factors of every day life.
Planning Act	*The Planning Act* is provincial legislation set out by the Province of Ontario that sets out the ground rules for land use planning in Ontario. It describes how land uses may be controlled, and who may control them.
Provincial Policy Statement (PPS)	The *Provincial Policy Statement* (PPS) is a guiding document in Ontario which sets the policy foundation for regulating the development and use of land. The PPS provides direction for all development on municipal scales and is often reflected in local level documents and planning practices.

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