Evaluating the Progress of Municipal Natural Asset Management through Monitoring & Evaluation

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

      Contemporary land-use planning in many Canadian municipalities is challenged with two key problems that have grown with increasing urban development: 1) infrastructure failure, and 2) natural ecosystems decline. The drivers of natural system decline often include an increase in grey infrastructure and residential developments replacing green natural spaces. These two problems (i.e., infrastructure and ecosystem decline) challenge the resilience of Canadian cities, raising concerns for the management of urban growth and environmental sustainability in light of the climate emergency.

      A possible approach for slowing or reversing this trend is the use of Natural Asset Management (NAM), Currently, many Canadian municipalities begun incorporating NAM into the municipal service delivery. As more local governments explore the potential benefits of municipal natural asset management, the Municipal Natural Assets Initiative (NAI) has recognized the need for a monitoring framework to enhance their existing evidence collection efforts. A monitoring framework is essential for assessing whether a program is progressing towards its goals and objectives. This thesis utilizes a NAM evaluation framework to understand the progress of NAM within these six municipalities: British Columbia: City of Courtenay and District of Sparwood; Ontario: City of Oshawa and Peel Region; and New Brunswick: Municipality of Florence Ville-Bristol, and the Southeast Regional Commission.

      These findings reveal that municipalities are successfully increasing their awareness and capacity for natural asset management implementation. However, the limited progress in NAM measures is directly related to a continued lack of knowledge of natural asset management, limited guidance for effective NAM policy, and limited municipal resources. These challenges can inhibit long-term efforts in support of natural asset management. Municipalities can overcome these challenges by focusing on the enablers of natural asset management. The prime enabler of natural asset management is the municipal effort for climate change adaption and resiliency, supported by provincial interest and legislation for ecosystem valuation.

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1.0 Background

Contemporary environmental and land-use planning in many Canadian municipalities is challenged with problems that intensify with urban development, e.g., 1) infrastructure decay (George & Sekine, 2017), and 2) natural ecosystem decline (Van Vliet, 2019). The Canadian Infrastructure Report Card of 2019 demonstrates that the state of infrastructure is worrisome, with around 70% of it past its useful life (Di Matteo, 2018; TCIRC, 2019). This risk is heightened because of the impacts that climate change may have on existing physical infrastructure, with the possibility of extreme weather resulting in infrastructure failure (CCA, 2019). In addition, many natural ecosystems are in decline within and surrounding sprawling Canadian cities (Statistics Canada, 2013; CCA, 2019;). The driver of these natural system declines is often an increase in physical infrastructure, replacing green spaces (Seddon et al, 2021). Loss of natural spaces poses a risk to the safety and resiliency of urban spaces and people, raising concerns for the management of urban growth and environmental sustainability in light of the climate emergency.

Possible approaches for slowing or reversing this trend include nature-based solutions (NBSs). Urban NBSs include natural infrastructure solutions aimed to provide municipal services through urban natural green spaces (Lafortezza & Sanesi, 2019). These provisions mitigate the impacts of the changing climate by regulating micro-climates in urban cities in place of removed natural spaces (Kabisch et al., 2017; Dorst, et al., 2021). However, many Canadian municipalities struggle to understand the importance of NBSs. The few progressive municipalities that have incorporated NBSs often have done so following a natural asset management (NAM) approach (NAI, 2019). However, as NBSs become increasingly applied,

evidence is needed to demonstrate their ability to reduce the risks of infrastructure decay and ecosystem decline.

The purpose of this thesis is to help build an understanding of how municipalities are progressing with NAM and how various factors shape it. It will do so by applying a standardized evaluation framework to a cohort of municipalities that have established a pilot natural asset management project, serving as case studies in Canada. This research explores a secondary cohort of case studies, as Phase 1 of this research previously evaluated a different set of municipalities. The current research will provide insight to planners, policymakers, and researchers, informing efforts for efficient evaluation of municipal NBS efforts and impacts. Strong evidence of NBS benefits through standardised evaluation will provide a convincing rationale for increasing its use in urban areas throughout Canada.

This thesis is divided into six chapters. The first chapter introduces the research topic with relevant background information with research objectives. In the second chapter, the literature is reviewed. Through that process, this thesis brings together research in NBS applications and program evaluation. Using the results from this literature review and the Phase 1 methodology of this research, an existing program evaluation framework will be modified to improve its efficiency and relevancy. The modified program evaluation framework is presented in chapter three. In the fourth chapter, the six case study municipalities are introduced. Evaluation results are in the fifth chapter. Chapter Six presents a discussion of the results consisting of opportunities, barriers, recommendations and suggestions for future directions of research.

1.1 The problems of sprawl: infrastructure and ecosystem decline

In contemporary planning, environmental planning is often an afterthought to mitigate challenges caused by rapid urbanization in Canada. Rapid sprawl has led to an abundance of grey infrastructure and low-density residential developments, often defined by their use of cement and asphalt. This sprawl has resulted in two key issues in Canadian municipalities: 1) failing infrastructure services and 2) the decline of ecosystem services.

1.1.1 Defining infrastructure decline

Physical infrastructure comes about as a direct result of increasing urbanization and human settlements. Grey infrastructure, defined as man-made and engineered infrastructure, is experiencing a decline in capacity as a result of financial and management issues. The literature suggests that the management of infrastructure assets should seek innovative ways to improve the capabilities and lifespan of existing and projected infrastructure to reduce overall management costs (Cooper et al., 2020). This innovation should consider the socioeconomic and environmental impacts of the overuse of grey infrastructure in urban development with a focus on ecosystem-based services (Mirza & Ali, 2017).

1.1.2 Defining ecosystem decline

Environmental impacts came to the forefront of public awareness in the 1960s and 1970s, following contributions such as Rachel Carson's The Silent Spring (Carson, 2000). Urbanization is a significant driver in the decline of ecosystems across North America (McKinney, 2002). In many North American regions, urban areas have become the predominant land cover class (next to agricultural lands) in comparison to natural land cover classes such as forests, wetlands, grasslands, lakes and rivers (Jarnagin, 2004). As a consequence, these natural ecosystems and their capacity to provide benefits for us have declined (Smil et al, 1998; Diaz et al, 2019). The

degradation of ecosystems is expected to worsen via demands made by a growing global population. The environmental impacts of urbanization through sprawl can be understood through land-use planning but there are gaps in the translation of this research into environmental policy at the municipal scale.

1.2 Defining a solution: Natural Assets Management

To understand Natural Asset Management (NAM), it is first important to discuss the awareness of ecosystem services. Ecosystem services are defined as the functions of ecosystems that provide, either directly or indirectly, benefits to people (Daily, 1997). Theoretically, ecosystem services were defined to understand the links between ecology and human needs (Groot, 1987, Groot et al. 2002; IPBES, 2018). Ecosystem features, such as water bodies, woodlands, forests, and grasslands, all provide beneficial services to human well-being. Past studies have led to the categorization of four types of ecosystem services. Provisioning services capture how the natural environment supplies food, fuel, and medicine (Lam & Conway 2018; IBPES 2018). Regulating services restrict the existing natural environment to bounded dynamics and limit the intensity and frequency of natural disturbances such as flooding (Lam & Conway 2018; IBPES 2018). Cultural services encourage a social connection between the natural environment and humans (Lam & Conway 2018; IBPES 2018). Support services consist of natural processes in the environment, such as soil nutrient dynamics, marine oxygen production, and carbon sequestration (Lam & Conway 2018; IBPES 2018).

Ecosystem services are often economically valued to understand the benefits they provide as natural capital (Westman, 1977; BenDor, 2019). The valuation of ecosystems can be used to justify their relevance in governing policies (Costanza & Daly, 1992; Costanza et al, 1997; Barbier, 2011). Commonly, municipalities will respond reactively to environmental impacts by

establishing environmental policies and plans, often guided by large state-level or federal policy documents. One can argue that municipalities are already acknowledging the value of ecosystem services. An example in Ontario is municipal partnerships with conservation authorities, as many municipalities benefit from the services of conservation authorities through the review of ecologically significant plans such as flood plain mapping (Church, 2018). Furthermore, many municipalities are utilizing the knowledge surrounding ecosystem services as a tool to justify changes to their existing delivery of municipal services in an attempt to adapt these services to meet environmental consequences as a result of urbanization (Thompson et al. 2019).

The term "nature-based solution" (NBS) is often used to define ecosystem-based infrastructure solutions that "can foster and simplify implementation actions in urban landscapes by taking into account the services provided by nature… NBS can increase municipal adaptive capacity and reduce the negative effects of a changing climate" (Kabish, 2017, pg. 9). Often, NBSs are considered a combination of both natural features and grey infrastructure to provide a hybrid approach that is utilized in light of emerging environmental issues, particularly climate change. For example, NBS solutions can consist of infrastructure such as green roofs, man-made wetlands, and bioswales (Hutchins et al, 2021; Arrington et al, 2023). As defined by the Natural Assets Initiative (NAI), municipal NAM is an approach that advances the recognition of natural assets for decision-making within the management of municipal assets (NAI, 2018, p.4). The linkages between these assets can improve the resilience of current grey infrastructure practices. The NAI suggests that this integrated approach shifts the focus of physical infrastructure from grey to green practices (NAI, 2018, p.6).

Currently, there is no federal or provincial public policy direction in Ontario compelling municipalities to implement NAM approaches (Baker et al., 2012; Todorova, 2017). There is

only some municipal consideration for defining green infrastructure as an adaptive approach to ecosystem services (Burch, 2010; Todorova, 2017, Province of Ontario, 2019). Hence, it is vital to increase understanding that a NAM approach should work in tandem with existing asset management plans. The literature suggests that NAM applications could garner more support from provincial and federal authorities as a comprehensive asset management strategy within sufficient evidence of municipal application (NAI, 2019).

1.3 Examples of Natural Asset Management

In Phase 1 of the larger evaluation program that the current study is part of, five municipalities, named Cohort 1, were evaluated. These municipalities all participated in a pilot NAM project with the NAI. The first cohort consisted of the (i) Town of Gibsons, British Columbia; (ii) City of Grand Forks, British Columbia; (iii) District of West Vancouver, British Columbia; (iv) City of Nanaimo, British Columbia; and (v) Town of Oakville, Ontario. NAI is a Canadian not-for-profit organization that provides scientific, economic, and expertise to Canadian municipalities to aid them in the process of identifying, valuing, and accounting for natural assets in their asset management plans and programs. Findings from Phase 1 indicated that municipal case studies are progressing well in terms of awareness and education regarding the use of NAM; however, they lack the resources and expertise for proper NAM implementation (Mollame & Drescher, 2021). Phase 1 results suggested that this shortcoming could be caused by a lack of organization, funding, and enabling policy.

To better understand what is limiting NAM outcomes, Phase 2 refined the methodology and scope of Phase 1, and then evaluated a new cohort of case studies: s. Hence, the second phase of this research involved a new cohort of six municipalities, as defined by NAI. This cohort consisted of the i) City of Courtenay, British Columbia; (ii) District of Sparwood, British

Columbia; (iii) Southeast Regional Service Commission, New Brunswick; (iv) Western Valley Regional Service Commission, New Brunswick; (v) City of Oshawa, Ontario; and (vi) Region of Peel, Ontario. This two-phased project aims to standardize NAM evaluation practices, provide feedback to pilot municipalities, and create transferable lessons of use for other municipalities.

1.4 Monitoring and evaluation: the key to NAM

Monitoring and evaluation are vital to the assessment of municipal programs and plans. Evaluation can be defined as the systematic assessment of a project, program or policy. Monitoring aids evaluation by providing the data required to quantify the indicators used to assess the activities enabled by said policy or plan (Seasons, 2021). Quantifiable environmental impact assessments and environmental monitoring began to gain prominence in the 2000s (Alexander, 2006). These environmental assessments can be categorized as performance evaluations. Performance evaluations assess the outcomes of a program or policy to help guide the decision-making process after a program or plan has been implemented (Seasons, 2021).

Despite the benefits that monitoring and evaluation can provide in planning practice, the literature indicates that many municipalities do not evaluate their plans regularly and fail to implement a continuous monitoring process that records the outcomes of their programs and plans (Guyadeen & Seasons, 2016). The evaluation of ecosystem-based programs and plans is even more limited, with minimal examples outside of project-based and provincially mandated Environmental Impact Assessments (EIA) (Ashnani et al, 2018). A large gap in the literature is understanding how to establish the indicators that assess the socio-economic and environmental performance of ecosystem-based programs and policies. The same gap is seen in the management of infrastructure assets and the monetary valuation of ecosystem services. Hence,

there is a lack of understanding of how ecosystem-based services perform as a part of municipal programs and plans.

The purpose of the current study was to continue the collection of result-based evidence of municipal natural asset management program outcomes in six Canadian municipalities. The current study pursued several objectives and with each objective are action items that were completed.

Objective 1: To explore the current state of the literature regarding asset management and NBSs.

A. Review natural asset management and the NBS literature.

B. Create a natural asset management literature database.

Objective 2: Review and update the existing evaluation framework for municipal natural asset management programs within the second case study cohort.

A. Review the relevant indicators measured from the previous cohort.

B. Review the evaluation literature.

C. Create an evaluation literature bibliography.

D. Modify the existing evaluation framework.

Objective 3: Application of the modified evaluation framework to the second cohort of municipalities in New Brunswick, British Columbia, and Ontario.

A. Interview relevant stakeholders.

C. Review relevant local government documents.

D. Analyze interviews and local government documents.

E. Populate indicators and cohort database with analysis results.

F. Produce outcomes in the shape of case studies.

G. Communicate evaluation findings and next steps.

Chapter 2: Review of the Literature

2.0 Chapter Introduction

The first section of the chapter explains the specific strategy used to gather the necessary literature. Following this, the review consists of a summary of the current practices, plans, and legislation for asset management in Canada. This leads to a review of ecosystem services and brings forth a definition, practices, benefits, and challenges with the implementation of ecosystem-based tools. The chapter then explores NBSs. This is followed by a discussion of the key enablers and challenges of implementing NBSs in municipal planning. Then, there is a discussion on research surrounding monitoring and evaluation in current planning practice, including a discussion of the challenges of monitoring and evaluation within the realms of asset management. The chapter concludes with current research gaps and key concepts that remain understudied in NAM.

2.1 Literature research strategy

The literature review describes the current state of NAM by combining literature on municipal asset management and program evaluation. The following bodies of literature were isolated: 'implementing municipal ecosystem services', 'nature-based solution implementation and monitoring', and "program evaluation methods".

Literature in the field of 'implementing a municipal ecosystem services framework' covers the widespread integration of ecosystem services consideration in municipal planning and plans in the last three decades. From federal legislation to municipal official plans, municipalities across Canada have been implementing different frameworks that utilize ecosystem services. Understanding the definitions, practices, and challenges behind the frameworks implemented provides insight into the history of municipal natural asset management practices (Chan et al.

2020). This is then followed by coverage of the body of literature in the field of "nature-based

solution implementation and monitoring" (Schaefer et al. 2015). This section of the literature

goes beyond ecosystem services and defines the practice of planning for and around the natural

environment. NBS literature presents an urban planning-based approach to the historical mindset

regarding ecosystem services. In doing so, this body of literature covers different infrastructure

strategies that municipalities implement to support their urban services, proving vital for

understanding natural asset management by municipal governments. The last body of literature

covers the field of "program evaluation methods" and is reviewed to design an effective

methodology for data collection and evaluation. Additionally, this section provides the basis for

reasonable modification of the monitoring and evaluation framework designed in Phase 1 (Fink,

2015).

The literature search began by using terms such as 'urban/urbanization', 'municipal',

'land-use, 'environment and planning, 'ecosystems', 'climate and stressors', 'infrastructure', and

'budgets'. The search hits were narrowed, beginning with addressing 'Ecosystem services in

planning policy through key terms such as 'ecosystem and benefits', 'ecosystem and adaptation',

'green and infrastructure', 'green and solutions', 'environmental and planning', and

'environmental policy'. To address 'Municipal natural asset management implementation', key

terms included 'climate and change', 'climate change and adaptation', 'NBS', and 'NBS and

implementation'. To address 'Program implementation and evaluation Methods', terms included

'plan and evaluation', 'plan and monitoring', and 'evaluation and framework'.

2.2 Understanding the history of asset management in Canada

A review of the current state of infrastructure and the history of asset management is

necessary to understand the policy dimensions that surround natural asset management. Physical

infrastructure comes about as a direct result of increasing urbanization and human settlements. Grey infrastructure is experiencing a decline in capacity as a result of financial and management issues (TCIRC, 2019; FAO, 2021)).

The decline in infrastructure severely impacted municipalities. Canadian municipalities have fiscal autonomy at the local level and, as a result, municipalities must engage in the design, management, and funding of their infrastructure. These activities are of critical strategic and operational importance for all municipalities (Harchaoui et al, 2003; Ashraf et al, 2016, Cooper et al., 2020). However, considering the decline in infrastructure quality since the 1970s, this autonomy has been hindered by budgetary cuts and it proved difficult for many municipalities to enact effective asset management planning (Harchaoui et al, 2003; Ashraf et al, 2016).

2.2.1 Defining enabling regulations and policy

In Canada, municipal governments are creatures of the provinces and territories, with responsibilities that are best managed under local governance. At the federal level, the regulations regarding municipal asset management are based on fiscal reporting. The Public Sector Accounting Board (PSAB), established in 2009, determined that Canadian municipalities are required to incorporate Tangible Capital Assets (TCAs) into their financial statements (Cranston, 2018, pg. 6). This requirement implies that municipalities must record their assets and their financial value for the life span of their use. As a result of the regulation, the asset data collected by municipalities is shared with the provincial governments to better identify where infrastructure investments are needed.

In addition to federal regulations, many provinces have also adopted additional requirements that municipalities are encouraged to follow. For instance, the Province of Ontario has implemented regulations regarding both financial reporting and plan development for better

management of local infrastructure. As of 2018, the Province of Ontario has implemented

regulation O. Reg. 588/17, under the authority of the Infrastructure Act, known as Asset

Management Planning for Municipal Infrastructure (O. Reg. 588/17, 2018). This regulation

requires Ontario municipalities to engage in asset management practices, including the creation

of an inventory, monitoring, and evaluation of infrastructure lifecycles, and a financial strategy.

Additionally, all Ontario municipalities were required to have an approved asset management

plan by July 2023 (O. Reg. 588/17, 2018). Similarly, in the Province of British Columbia (BC),

asset management planning is undertaken by a combined effort of the Ministry of Municipal

Affairs and the Union of BC Municipalities, as a means to aid municipalities to develop asset

management plans through planning grants, training subsidies, and the development of asset

management resources (Government of British Columbia, 2023). Although the Government of

BC does not require asset management plans, the management of assets is supposed to follow the

Capital Asset Management Framework (CAMF) that provides minimum standards, policies and

processes for managing capital assets (Government of British Columbia, 2023).

Despite this provincial regulation and support, many Canadian municipalities are still

struggling to fund infrastructure rehabilitation and restoration (Schiefke, 2022). As

municipalities continue to urbanize and demands for municipal services increase, infrastructure

continues to deteriorate, demands for municipal services rise, and municipalities struggle to keep

up. As of 2021, the Financial Accountability Office of Ontario (FAO) estimated that the current

municipal infrastructure backlog could range from $45 to $59 billion (FAO, 2021). The backlog

suggests that despite the estimated $484 billion spent on infrastructure management and

development since 2020, approximately $52 billion would be required additionally to repair

failing infrastructure. The FAO also estimated that there is approximately $47 billion of debt for

municipal assets from municipalities they are failing to report. Hence, the literature suggests that despite the federal and provincial push for asset management practices and plans, many municipalities across Canada struggle to maintain their infrastructure as a result of budgetary and resource constraints.

2.3 Defining Ecosystem Services

Ecosystem-based services are defined as the functions of ecosystems that provide beneficial services to people (Daily, 1997). Theoretically, ecosystem services were defined to understand the links between ecology and human needs (Groot, 1987, Groot et al. 2002; IPBES, 2019). Ecosystem features such as water bodies, woodlands, forests, and grasslands all provide beneficial services to humans and support their well-being. Recent literature has been able to categorize four types of ecosystem services. The first is provisional services that utilize the natural environment for food, fuel, and medicine (Lam & Conway 2018; IBPES 2018). Second, is regulating services that mediate the natural (Lam & Conway 2018; IBPES 2018). Third is cultural services that encourage a social connection between the natural environment and humans (Lam & Conway 2018; IBPES 2018). The fourth is support services consisting of natural functions of the environment such as carbon sequestration, nutrient cycling, and water purification (Lam & Conway 2018; IBPES 2018).

Ecosystem services are often given an economic valuation to quantify the benefit they provide as natural capital. (Westman, 1977; BenDor, 2019). The valuation of ecosystems can be used to justify their relevance in environmental policies (Costanza & Daly, 1992; Costanza et al, 1997; Barbier, 2011). Commonly, municipalities will respond reactively to environmental impacts by establishing environmental policies and plans, often guided by large state-level or federal policy documents.

2.3.1 Gaps within Ecosystem-based services knowledge

Despite the growth of knowledge of and utilization of ecosystem-based services, the practice faces many challenges (Lo 2016; Chaplin-Kramer et al. 2019; Díaz et al. 2019; IPBES 2019; Sachs & Reid 2006). There are at least five main critiques seen in the literature (Chan et al., 2020): (i) the need for biophysically informed valuation, (ii) the limited applicability of monetary valuation, (iii) the need to include measurements of demand and access, (iv) the need to tailor communication of ecosystem services for industry application, and (v) the challenges with social inclusion with ecosystem services.

For this study, the two gaps that are significant to urban planning are the lack of long-term evaluation of ecosystem service programs and the limited effectiveness of policies in addressing biophysical underpinnings. The first critique, the need for biophysically informed valuation, suggests that historical research into the valuation of ecosystem services was based solely on monetary values and monetization (Costanza et al. 1997). This monetization approach is limited as it does not account for the constant biophysical changes and the benefits that come with changes in a natural ecosystem. Following the second critique, this limitation is heightened by the lack of monitoring and evaluation of ecosystem-based services. The third critique highlights the need to include measurements of demand and access. This critique is based on research that suggests that ecosystem services planning is based on a limited understanding of the dynamic changes of ecosystem services and has done little work toward understanding the benefits of implementing ecosystem-based services (Berbés-Blázquez et al. 2016; Nesbitt et al. 2019; Wieland et al. 2016).

These critiques suggest that since research into the utilization of ecosystem services is still emerging, there is a knowledge gap between research-produced data and application-based

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data that can only be closed through effective biophysical metrics or measurements of natural assets. Furthermore, if this research can encourage monitoring and evaluation, it can then lead to the creation of policies and plans in urban environments to embed the concepts of ecosystem services within municipal planning (Liu et al. 2015; Fürst et al. 2015).

2.3.2 Challenges with the integration of the ecosystem services concept into planning practice

As the research and understanding of ecosystem services grows, the use of ecosystem-based services has seen an increase within planning practice (Lam & Conway, 2018; Schubert et al., 2018). With the growing pressure of urban climate change impacts and associated links to declining natural systems, many Canadian municipalities have begun adapting ecosystem-based practices as a resilience solution (Cortinovis & Geneletti, 2018). The adoption of ecosystem-based practices is rooted in the goal of progressing towards a long-term resiliency that focuses on existing natural systems and the understanding of municipal assets through a monetary values lens (Albert et al., 2019; Schubert et al., 2018).

A common example is municipal partnerships with conservation authorities within Ontario, as many municipalities benefit from these services through a review of ecologically significant plans such as floodplain management (Church, 2018). Furthermore, many municipalities are using ecosystem services as a tool to update and justify changes to their delivery of municipal services, in an attempt to adapt to emerging challenges that are a consequence of urbanization (Thompson et al. 2019). The key challenge is that there is a lack of guidance within institutions on understanding ecosystem services and then translating them into policies and plans (BenDor et al., 2017; Lam & Conway, 2018).

The planning literature also suggests that there is a lack of practical guidance for planners to implement ecosystem services within their municipal plans and policies (Albert et al.,

2014; Albert et al., 2019; BenDor et al., 2017; Cortinovis & Geneletti, 2018; Lam & Conway, 2018; Rozas-Vásquez et al., 2018). This lack of practical guidance further highlights an application gap. In their review of environmental policy, Lam and Conway (2018) noted that although ecosystem services were often identified within many Ontarian municipal land use policies, their application and use are not explicit and they lack definitive implementation.

2.4 Understanding ecosystem-based tools: nature-based solutions

NBSs were first defined in the literature by the World Bank in 2002 (World Bank, 2017). NBSs are considered a combination of both natural features and grey infrastructure to provide a hybrid approach that is utilized to address environmental issues, particularly climate change. In the last two decades, there has been rapid adoption of NBSs through the use of green infrastructure (Escobedo et al, 2019; Wang and Banzhaf, 2018; Koc et al, 2017). Research has focused on exploring the origins of the term (Koc et al, 2017; Mell, 2016), case studies of green infrastructure (GI) initiatives and research examining the implications of framing nature as infrastructure (Lennon, 2015). NBS solutions include green roofs, man-made wetlands, bioswales, and vegetation used for erosion prevention (Hutchins et al, 2021). GI is often defined as a complex network of natural and semi-natural infrastructure that can provide multiple benefits through the use of ecosystem-based services, resulting in positive ecological, economic and social benefits (Benedict & McMahon, 2002, 2006; Ely & Pitman, 2014; Jacobs, Mikhailovich, & Delaney, 2014).

2.4.1 Enablers of implementing NBS infrastructure

GI includes establishing urban parks, urban gardens, and sustainable urban drainage systems. The use of these GI types results in the delivery of ecosystem services and features that enhance their surrounding environments aesthetically, socially, and ecologically. Effective GI delivery varies based on geography and common infrastructure systems will vary in their

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benefits. Therefore, it is important to identify local patterns and areas that can sustain consistent use and continue to provide co-benefits, defined as additional outcomes that arise from the use of ecosystem-based tools (Gomez Martin et al. 2020; Vicente-Vicente et al. 2019). Recognizing patterns in ecosystem capacity across an urban area can help management allocate resources to areas that may be under-supported or allow for synergies between different co-benefits and nature-based solutions.

Another benefit of implementing GI initiatives is providing economic opportunities, such as "green jobs" and the selling of carbon offsets as a new investment instrument, contributing to international targets such as the United Nations Sustainable Development Goals (SDGs). In sum, GI:

(1) is cost-effective in producing specific target services or service bundles.

(2) provides co-benefits because of additional ecosystem service generated, and

(3) can carry an option value considering uncertainty about future service delivery and needs (Kroeger et al. 2019).

Furthermore, "green jobs" and carbon offsets can be based on the restoration, conservation, and maintenance of GI, and can enhance city branding (Gomez Martin et al. 2020; Vicente-Vicente et al. 2019). To meet biodiversity targets and SDGs, there is political pressure and public support to reconnect fragmented landscapes and nature reserves through GI elements such as corridors, eco-ducts, or buffer zones, working toward biodiversity conservation. These elements can provide a network through which organisms, energy and matter move more freely across the landscape and thus better contribute to ecosystem services (Llorente et al. 2016; Maes et al. 2015).

Finally, utilizing different forms of knowledge held by people of different backgrounds can better elucidate the entire range of ecosystem services. For example, the knowledge provided by environmental education services is associated with urban worldviews, whereas local ecological knowledge tends to be linked to rural worldviews (Martin-Lopez et al. 2012). In addition, engaging citizens' sense of place and their knowledge regarding local natural heritage allows municipalities an opportunity for the co-creation of narratives on the technical and social-cultural stewardship of GI (Gulsrud et al. 2018). This expanded knowledge base provides for a broader assessment of ecosystem services (Koscielniak & Gorka 2016; Abramowicz & Stepniewska 2020; Gomez Martin et al., 2020; Whitehead et al., 2016). All of these considerations culminate in:

(i)   more reliable engagement of private partners for full funding,

(ii)   application of the most recent approaches and technologies,

(iii)   reduced political pressure,

(iv)   marketing benefits,

(v)   broadening of the knowledge base, and

(vi)   fulfilment of diverse needs and interests.

2.4.2 Challenges of implementing NBS infrastructure

There are three key challenges for NBS infrastructure mentioned in the literature: GI delivery, infrastructure funding, and infrastructure monitoring. To begin, the first challenge of GI delivery stems from limitations within current planning practices used to enable green initiatives. This limitation is a result of the difficulty in regulating and accessing ecosystem services and leads to scarcity in local ecosystem service (ES) delivery and a lack of planning knowledge.

Lack of time and resources, and insufficient best practices that sustain urban ES, are usually not considered in the planning and design process, particularly regarding green spaces (Vicente-Vicente et al. 2019).

Furthermore, policy choices or plans that are short-sighted or that focus too heavily on ESs can be detrimental to environmental resilience, societal needs, or both. Effective plans and policies must consider how to implement GI, how to integrate existing GI, and how to convert existing natural resources into a GI network (Vicente-Vicente et al. 2019; Pozoukidou, 2020). Mistakes in governance decisions during environmental crises can create disorganization within local governments, which hinders actions towards preserving scarce natural resources, including water. The lack of robust and efficient policies amplifies the effects of crises and promotes unequal experiences of resource shortages among the population. For example, during drought periods, urban gardeners must know ahead of time how much water they may use and not exceed watering regulations, thus requiring clear municipal communication (Elmqvist et al, 2004, Lin & Egerer 2020). ES management in one area often appears to be conducted in isolation from other ecosystems. Also, actions taken by one municipality can affect adjacent municipalities' use of green space. Thus, there is a need for inter-municipal coordination to reach the goals of sustainable development for a region (Elmqvist et al, 2004).

The second challenge for NBS infrastructure is the lack of financial support for such initiatives. There are four main difficulties with providing funding for GI projects:

(i)   the lack of implementation of integrated solutions,

(ii)   the need for faster project evaluation by investment banks,

(iii)   the need for lower interest rates for projects, and

(iv)   the considerable cost for the maintenance of green spaces, which municipalities

may not be able to fully provide (Koscielniak & Gorka 2016; Verdu-Vazquez et

al. 2020).

For example, during recessions, especially in developing nations or developed nations where

environmental management funds are supplied by non-governmental organizations, compliance

efforts for GI management are reduced, and more emphasis is placed on economic development.

This can result in the community being more accepting of a reduction in ES supply, poor water

quality, and reduced monitoring efforts.

Limitations in funding or access to funding can mean that a municipality must limit

permitting and monitoring, thus affecting compliance with green initiatives (Gibbs, 2015).

Furthermore, urban areas with lower socio-economic status are less able to afford the

maintenance costs that come with the landscaping of public green spaces and with the expansion

of private gardens with high concentrations of woody species. As these woody species deliver

regulating services, such as carbon sequestration, these disadvantaged neighbourhoods are

exposed to inequities in the delivery of these ESs (Cilliers et al., 2013).

The third challenge for NBS infrastructure involves monitoring and evaluation. This

challenge is two-dimensional, including monitoring and evaluation. Consequently, a need is

recognized to document ecological processes at the appropriate scale for effective decision-

making and management. Several articles note that while past work has been beneficial, more

effort needs to be put into monitoring and evaluating practices, as well as integrated model

development for ESs. Proper ES indicators need to be developed and connected to management

objectives and goals (Elmqvist et al., 2004).

There are several notable problems in the design of monitoring and evaluation frameworks for NBSs in cities. These problems include (i) the consideration of social dimensions as secondary to environmental dimensions, (ii) the mixing of outputs and outcome indicators, (iii) the lack of consideration of public health, (iv) the lack of evidence on the different users of NBSs, (v) the failure to account for ecosystem disservices, (vi) the lack of data on the long-term effects of NBSs, and (vii) the limited ability to measure synergies and trade-offs (Chapman 2014; Gibbs 2015; Dumitru et al., 2020).

These problems challenge the position of decision-makers because they require more diverse and explicit parameters to measure the effects of land-use changes on ecosystems rather than just monetary valuation efforts of affected ESs (Zhao et al., 2004). Political leaders face many challenges in applying ecosystem-based adaptation measures and then in monitoring and evaluating these measures. These challenges include the requirements for new skills, the need to build partnerships, minimizing ecosystem disservices to users, and, most importantly, strengthening the political will to protect ecosystems and their services (Gibbs 2015; Cilliers et al. 2013; Torres-Lezama et al. 2010; Dumitru et al., 2020).

2.4.3 Implementing municipal natural asset management as an NBS

Given the definition of NBS, municipal natural asset management (NAM) itself is a management approach for NBS infrastructure, as it aims to utilize ESs to address the decline in infrastructure capacity within municipalities (Albert et al, 2019; Vidya et al, 2022). NAM is an emerging ecosystem-based approach within the planning practice as a way to integrate ecosystem services and asset management into one comprehensive practice. As defined by the Municipal Natural Assets Initiative (NAI), municipal natural asset management is an approach that advances the recognition of natural assets for decision-making within the management of

municipal assets (NAI, 2018, p.4). The linkages between these assets can improve the resilience of current grey infrastructure practices. NAI indicates that this integrated approach shifts the emphasis of physical infrastructure from grey to green (NAI, 2018, p.6).

Furthermore, NAM goes beyond man-made NBS infrastructure to define the use of municipal natural assets. This definition by NAI states that natural assets fall under the umbrella of GI but are distinguished from man-made or engineered assets such as rain gardens, permeable pavement, and green roofs. NAI specifically defines natural assets as "the stock of natural resources and ecosystems that yield a flow of benefits to people (NAI, 2018, p.3). These municipal natural assets, such as forests, watercourse networks, riparian areas, and shorelines, provide the existing ESs that are to be incorporated into municipal plans and policy. Examples of this integration can be seen in public policy at a grassroots level in Ontario. O. Reg. 588/17 states 'green infrastructure asset means an infrastructure asset consisting of natural or human-made elements that provide ecological and hydrological functions and processes and includes natural heritage features and systems, parklands, stormwater management systems, street trees, urban forests, natural channels, permeable surfaces, and green roofs". An all-encompassing definition that considers natural and engineered green assets.

Furthermore, NAM provides support to existing engineered assets. In comparison to . engineered assets that are often designed for a singular purpose, NAM provide a series of benefits, or co-benefits as a result of their existence. NAI defines this as the variation in the levels of service. For example, a municipality may choose to utilize both natural and engineered infrastructure for flood management, however, the natural asset provides a level of service outside of flood management. The natural asset can reduce stress on the existing infrastructure by deviating a percentage of the flood water flow but also continue to provide resulting in co-

benefits such as citizen safety, and cost reduction for any damage the engineered infrastructure my have experienced as a result of overflow (NAI, 2022). The benefits that NAM provides cannot be rooted in a singular level of service, by definition NAM will continue to provide ecological benefits and provide additional levels of services that contribute to the longevity and maintenance of supported engineered assets.

Despite the increasing awareness and efforts taken through provincial policy, there is no concrete policy direction to implement NAM approaches (Baker et al 2012, Todorova, 2017). There is minimal municipal consideration for defining GI as an adaptive approach to managing ESs (Burch, 2010; 2014; Todorova, 2017, Province of Ontario, 2019). An NAM approach must work in tandem with existing asset management plans. The literature suggests that NAM applications could garner more support from provincial and federal authorities as part of a comprehensive asset management strategy (NAI, 2019).

2.5 Municipal monitoring and evaluation

Monitoring and evaluation are vital to the assessment of municipal programs and plans. Evaluation can be defined as the systematic assessment of a program or policy. Monitoring aids evaluation by providing an indicator base to assess the activities enabled by said policy or plan (Seasons, 2021). These environmental assessments can often be categorized as performance evaluations. Performance evaluations assess the outcomes of a program or policy to guide decision-making processes while the program or plan is being implemented (Seasons, 2021). Despite the benefits that monitoring can provide in planning practice, the literature suggests that many municipalities do not evaluate their plans regularly and fail to implement a continuous monitoring process (Guyadeen & Seasons 2016). A large gap is often how to establish indicators

that assess both the socioeconomic and environmental performance of these ecosystem-based programs and policies.

2.5.1 Challenges of municipal evaluation

In municipal services evaluation, the literature suggests several challenges that create gaps between theory and application. The primary challenges comprise a lack of effective evaluation methodologies, an attribution gap, and several institutional barriers, such as resources, funding, and staff (Guyadeen & Seasons, 2018; Seasons, 2021). The first challenge revolves around the fact that often there is little evidence that a municipal policy or a plan has been successful. The success of a plan is often defined by variables of implementation that can include goals, targets, timelines, funding, and subsequent outcomes (Seasons, 2021). This challenge is a result of a gap between theory and application (Berke et al. 2006; Brody et al. 2006). While the intention of a plan is easier to define, its implementation is often affected by external factors such as the resources available to the planning agency or the stakeholders, as well as public influence and needs which can derail a plan (Guyadeen & Seasons, 2018). There is less research on how plans can be improved or better implemented. Many municipalities often outsource plan-making to consulting firms, which may look at prior cases from other municipalities. This approach tends to perpetuate the status quo and limits innovation.

The second challenge is connected to indicator use. Recent work by Seasons (2021), suggests that municipalities are placing increasing value on the use of indicators within their implementation efforts to generate program evaluation models. Seasons states that indicators can be quantitative or qualitative and can address 'resources, inputs, desired and unintended outcomes, interim markers of success, program processes, program environment, and trends and patterns related to these factors' (Seasons 2021, pg. 44). Whereas indicators can provide

direction for data collection, there are several challenges when selecting indicators, which is known as the attribution gap. The attribution gap criticizes the lack of evidence-based selection of indicators (Guyadeen & Seasons 2018). With little evidence that addresses the effectiveness of indicators, the indicators may fail to adequately evaluate the targets or goals set by a plan (Dobbs et al. 2011, Seasons, 2021).

The third challenge involves the institutional barriers that can arise with the implementation of a plan and its evaluation. These challenges often present themselves as restraints within the municipalities or political constraints (Guyadeen & Seasons, 2018, pg. 107). Municipalities that have issues with organization flow and goal creation result in a strenuous process of drafting plans and policies. As a result, this leads to ineffective plan implementation, which may hinder the ability of a municipality to evaluate plans.

2.8 Key findings

Natural assets produce various ESs that can be utilized through an ecosystem-based program. However, the use of the ESs is not fully understood due to the difficulties in equating monetary and social values to natural assets at the municipal level. Despite the long history of planning policy that integrates environmental considerations into municipal decision-making, there needs to be a stronger balance between planning for the built environment and natural assets (Government of Canada, 2021). The literature indicates that traditional considerations for infrastructure development must consider the ecological benefits of natural assets. To understand and close the gap between natural asset management planning and outcomes, there should be further exploration of case studies to understand the practical application of ecosystem-based services plans.

NBSs, such as NAM, are emerging planning practices that have received limited M&E efforts to confirm their benefits at a municipal scale. With NAM assessed through rigorous program evaluation efforts, this information could present a compelling argument to municipalities that their grey infrastructure can be strengthened with the use of natural assets. Additional research should also address how NAM could be structured and managed for municipalities to implement the practice in their land-use planning practices (Schäffler & Swilling, 2013; Maring & Blauw, 2018). Research should aim to define existing uses, similar to prior studies in ES and GI, that provide support for these approaches and some form of standardized application (Cortinovis & Geneletti, 2018).

Chapter 3: Methods

This chapter provides detail on the methods used to collect and analyze data used for the current study. The section describes the evaluation matrix used to analyze the collected data. Following this, the modification of the evaluation matrix Phase 2 of this research is explained. The data collection methods are defined in detail, along with ethical considerations. To conclude, the data analysis methods are described, as well as the limitations of the methodology.

3.0 Introduction

The methodological framework follows a program evaluation approach through case studies. Case studies are the ideal approach for this methodology, as the current research aims to understand the real-life context of NAM practices (Farthing, 2016, p. 116). The case study municipalities are further described in Chapter 4. Program or plan evaluation is a qualitative process. This is the case for the current research, as it involved the use of literature and document review, as well as semi-structured interviews, to understand the context and application of a program or plan (Fink, 2015). A qualitative approach provides the most comprehensive collection of data that will allow for an effective evaluation matrix framework to be created. Further, the case study design allows for an in-depth understanding of NAM as applied in reality, which enables obtaining insights about the research subject and formulation of hypotheses for future research.

Phase 1 of this research was completed in 2021. This phase created an evaluation framework and an evaluation matrix for data collection and analysis using the guidance of Bamberger (2012), a program logic approach, and Seasons (2021) for planning this specific evaluation. In the current Phase 2, the earlier framework is reconsidered and focused on indicators that are related to municipal documentation instead of interviews. Unlike Phase 1, the

current study utilizes document review for data collection and analysis, highlighting some of the limitations of interviewing as a method of data collection. The review utilizes textual analysis in the form of thematic coding to deduce results from the collected data.

3.1 Phase 1: creating the evaluation framework

Phase 1 of this research defined four steps to develop the evaluation framework (Mollame & Drescher, 2021). The first step was to understand the intent of the exercise at hand and the expectations of the involved stakeholders (Seasons 2021, pg. 114). The evaluation framework for this research was of a formative and conformance evaluation type (Bamberger et al. 2012, pg. 211 & 214). The purpose of a formative evaluation is to help program operators to improve the design and implementation process of an ongoing project. Additionally, formative evaluation can also serve to inform future projects (Rossi et al. 1999; Wholey 2004). The formative analysis will also result in data-based evidence for additional municipalities that are considering a NAM project and aid them in the process of developing a NAM implementation strategy. Furthermore, this evaluation framework includes aspects of a conformance evaluation type. Conformance evaluation is reflected by the framework as the goals and intentions formulated by the case study municipalities are compared to the actual outcomes of their natural assets project. The purpose of a conformance evaluation is to consider the work that was done beyond the implementation of a project (Guyadeen & Seasons 2016; Laurian et al. 2004).

The second step was to determine the evaluation design. From a planning perspective, the evaluation design also must consider the current research paradigm. Hence, the current study adhered to a pragmatic approach (Seasons 2021, pg. 199). This approach was best suited for this research as the created evaluation framework must be rigorous but applicable to various municipal natural asset programs and projects, as well as connect well with municipal staff and

stakeholders. Furthermore, when considering the evaluation design, it is important to consider the timeline of the program cycle and the commissioned evaluation, the timeline of the data collection methods, and whether well-matched control groups are available (Bamberger et al. 2012, pg. 215-216). In the context of the case study municipality program cycles, the evaluation took place post-implementation and towards the end of the initial NAM projects. Hence, the data collection was also post-implementation and no control groups were available.

The third step involved the identification of indicators and benchmarks. The purpose of the current study was to understand the outcomes of each municipal NAM project. These outcomes are assessed through indicators as set standards for effective comparison between project goals and actual outcomes. Indicators can be either qualitative or quantitative variables to define the status or trend of a project or program (Weiss, 1998; Seasons 2021). In comparison to indicators, benchmarks are the critical values that the indicator variables have to reach (Baker & Wong 2006; Barrados & Blain 2012). The developed framework utilized indicators for each program outcome. However, since the current research focused on the assessment of planning practices, plans, and policies concerning each NAM project, it did not include the evaluation of biophysical indicators. Evaluation of biophysical indicators would have required long-term measurements of environmental variables, which was beyond the scope of the current study.

The fourth step was to select the methodological approach to data collection and analysis. Often, program evaluation frameworks employ a mixed methods approach, but with a greater emphasis on qualitative methods, which is similar to the current research through the use of interviews, literature analysis, document reviews, and the use of case studies (Seasons 2021; Fink, 2015). The extracted text from interviews and documents was then coded through text analysis.

3.1.1 Finalized framework

    Once the evaluation framework was defined, it could be used to create an evaluation matrix that led to the development of a scorecard. To design the evaluation matrix, a program logic model was used. A program logic model was the best fit for the current research as it was based on an input-output model, resulting in outcomes or impacts that are measured (McLoughlin & Jordan 2004). The program logic model, in practice, was meant to guide the evaluation process and to:

1. Identify potential issues in the evaluation framework and improve data collection and analysis.
2. Identify factors of program successes and failures and improve the design of the evaluation.
3. Communicate all components of the program to stakeholders.

The program logic model helped to identify four different outcome streams. Unlike a classic program logic model that models only one series of outcomes and impacts, outcome streaming uses links between several types of outcomes or impacts. Phase 1 of this research identified four outcome streams (Mollame & Drescher, 2021):

1. The awareness, education, and capacity outcome stream are focused on two desired outputs: (i) the education of municipal staff concerning NAM for plans and policy objectives, and (ii) the need for public education and awareness for municipal accountability. This outcome stream is addressed through consultation sessions and partnerships.
2. The implementation outcome stream is based on the outputs of short-term changes to strategy, policy and bylaw, programs, financing, investments and operations. These

outputs are assessed based on the changes a municipality has made to its different types

of plans and policies.

3. The ecosystem rehabilitation and restoration outcome stream are based on medium-term

   outcomes that relate to the health of existing natural assets and a municipality's ability to

   implement future projects concerning ecosystem rehabilitation or restoration projects.

   This outcome stream is assessed by evaluating a municipality's ability to plan and

   implement restoration projects and measure their performance.

4. The service delivery outcome stream focuses on medium to long-term outcomes of NAM

   projects. This outcome is intended to measure the service levels provided by natural

   assets and their ability to supply co-benefits. Co-benefits can be defined as secondary,

   additional benefits a municipality experiences from its natural assets, such as in terms of

   climate change mitigation or enhanced recreational opportunities (Scovronick et al.

   2019). This outcome stream is assessed by how a municipality is valuing provided

   service levels and co-benefits.

3.1.2 The evaluation matrix

Following the design of the evaluation framework, the evaluation matrix was created. An

evaluation matrix (Figure 1) was created on the base of evaluation questions concerning the four

outcome streams, classified according to thematic clusters that refer to the program's direction

and progress (Markiewicz & Patrick 2016). Hence, the purpose of the evaluation matrix was to

create links between the outcome streams and the evaluation questions. The development of the

evaluation questions was an iterative process (Seasons, 2021 pg. 129), as the final set of

questions must be logically connected with the program outcomes and grounded in the needs of the program (Seasons, 2021). To ensure this logical connection, the evaluation questions were reviewed by key stakeholders involved in the NAI and ranked for importance. Ultimately, ten of a possible 26 evaluation questions were selected and used for the current evaluation based on stakeholder feedback (Appendix 2). Following the finalization of the evaluation questions, the indicator variables, data sources, analysis methods, timings, and benchmarks were created for the matrix.

Evaluation Question/Problem	Indicator	Data Source	Analysis Method	Timing	Benchmarks
AC3 *Question 1 – Have the municipalities made the general public aware of natural asset management occurring?*	Number of townhalls, information sessions, and other general consultation events on NAM	Local government records and meeting minutes on public consultation efforts	Percentage of NAM consultation events with high attendance in comparison to other consultation events	After initial public consultation efforts and the dissemination of informational materials	More than 50% of NAM consultation events have a high attendance rate from local citizens
		Information materials disseminated to the public	Coded segments of information materials list importance of conducting MNAM		All (100%) of information materials describe one reason for conducting MNAM
To what extent is the program meeting implementation outcomes?					
Goals: To ensure appropriate changes and steps in planning and municipal development process to reflect the importance of MNAM in municipal service delivery					
IL1 *Question 1 – Have the municipality and relevant stakeholders identified any barriers or opportunities to MNAM within the project community?*	Number of barriers or opportunities identified in MNAM delivery within the project community	Local government planning documents and stakeholder responses to MNAM e.g.: - White papers - Technical reports - Financial summaries - Investigative journalism	Percentage of government documents and consultation process reviews that clearly identify the issue of barriers and opportunities with specific examples	After municipality has completed capacity-building outcomes	100% of topically relevant government documents and reviews identify barriers and opportunities and provide specific examples

Figure 1. Example of the Evaluation Matrix (Mollame & Drescher, 2021)

3.2 Phase 2: Data Collection

Since the current study was a second phase of previous research, a new set of municipal case studies were evaluated. These case study municipalities are located in three provinces within Canada:

a. British Columbia: City of Courtenay and the District of Sparwood,

b. Ontario: City of Oshawa and Peel Region,

c. New Brunswick: Town of Florence Ville-Bristol and Southeast Regional Service Commission (SERSC).

The use of a national cohort of case study municipalities increases the understanding of different NAM practices across different planning legislations. The data are classified as primary (interviews) and secondary (documents). The primary data were collected by conducting interviews with municipal staff and experts in the case study municipalities.

Data access was facilitated by NAI, making the data collection a result of convenience sampling. NAI has pre-established NAM pilot projects across various municipalities. While NAI's work started with the municipalities in Cohort 1 and Cohort 2, currently they are working with over 100 Canadian municipalities.

3.2.1 Document review
The first method of data collection was a document review for each case study municipality. Documents are vital to understanding how each municipality functions, their practices, and decision-making (Bowen, 2009). Document reviews are often conducted within a program evaluation to gather information on how a program is defined and implemented. Depending on the length of the period between project implementation and program evaluation, a document review can also reveal outcomes and impacts of a project (Trevisan & Walser 2015, pg. 25). In the current case, a document review was especially beneficial as data were readily accessible, with a majority of documents being online. Document review can also provide information that is outside of the narrower focus of the program evaluation, such as municipal

context or background (Russ-Eft & Preskill.2009). Despite these advantages, a document review can have drawbacks, such as when documents are misinterpreted or interpreted outside of their original context, which can reduce the reliability of the results (Russ-Eft & Preskill, 2009).

Collecting data from municipal documents began with a review of the NAI pilot projects in the case study municipalities and corresponding reports. Each municipality provided a summary and technical report associated with their pilot project. These documents also included details and links to relevant data inventories and maps. Following the review of these reports, additional municipal documents were collected, including official plans, zoning bylaws, strategic plans, and any document that related municipal natural asset management to policies or plans. These documents provided the context of the goals and objectives of each municipality and defined their policies and specific language used when addressing NAM. For more details about the NAM efforts, technical documents including project reports, council and committee meeting notes, and public engagement or consultation efforts were reviewed. These documents were well-suited for extracting information concerning the previously described indicator values and the evaluation matrix.

All reviewed documents were within the public domain and were accessible through the municipalities' websites. Similar to a literature review, key search terms within the evaluation matrix were used to locate relevant documents on municipal websites. Additional documents were retrieved through "snowballing" (Wohlin 2014, pg. 1), i.e., the acquisition of new documents using links highlighted by the documents' reference lists.

3.2.2 Interviews

Following the initial collection of data through document review, interviews were conducted for willing municipalities. Within program evaluation, interviews are often a common and critical method for data collection, as interviews can provide the opportunity to collect information that is lacking or misinterpreted by the evaluators when reviewing written documents. Interviews also provide an opportunity to collect information on how staff interpret the implementation and progress of a program (Seasons 2021, pg. 156). Given that the document review took place before the interviews, the interviews were semi-structured, focusing on questions that still lacked information from the initial document review. Semi-structured interviews allow for a level of comparability between interviewees and ensure connection to study objectives, but also provide flexibility for discovering new insights (Bryman et al. 2009). The interviews followed an interview guide, comprised of 10 specific questions (Appendix 2). Each interview guide was tailored to a specific municipality depending on what questions, or part of the evaluation, required additional information.

Interviews were secondary to document review based on the assumption that effective program implementation would be documented by the municipality. However, conducting interviews has limitations. They can be susceptible to biases and their interpretation may differ based on the prior understanding of the interviewer. Despite the use of focused questions that are supplied in advance of the interview, there may be no information available for the interviewee to share. However, these limitations can be overcome with the use of open-ended questions. Open-ended questions provide an opportunity for critical information to be revealed by those who work closely with the program or project being evaluated (Bryman et al. 2009). Effective use of open-ended questions requires additional guiding effort from the interviewer to ensure that the interviewee does not speak outside the topic or progress rapidly through the questions.

The interviews were conducted with municipal staff remotely via teleconferencing to accommodate constraints due to geographic distances and COVID-19-related safety measures. The primary application used was the remote meeting platform Microsoft Teams. Each interview lasted about 1 hour. These interviewees were transcribed using the Microsoft Teams transcription tool and were only video or audio-recorded when given verbal consent by the interviewee. Interviews were only conducted for municipalities that were willing to discuss their NAM; however, all municipalities were informed about the program evaluation. If not available for an interview, municipal staff were sent a list of main document review results and asked to confirm if the results were valid.

3.3 Data analysis

This current study applied a qualitative content analysis approach for the analysis of the reviewed documents and interview transcripts. The specific form of qualitative content analysis applied is known as text analysis (Farthing, 2016). Text analysis is ideal for breaking down text that may be extracted from documents or interviews, after which it is coded and thematically analyzed. For the current study, the text was coded using categories and themes based on the evaluation matrix. Once the text was coded, thematic analysis was used to identify patterns within the coded data (Bamberger et al. 2012, pg. 314). The identification of emergent patterns or themes then allows for the creation of a presentative narrative of the data. The process of layering textual analysis with thematic analysis is particularly useful for the current study, as it is possible to use specific codes that distinguish between the various municipalities. Furthermore, coding allowed a level of quantification of program outcomes that was used for certain indicators, in particular indicators that required a count or number of program outcomes. However, quantification was rarely used to avoid misinterpretation, as frequency counts do not

always demonstrate performance concerning the design of the evaluation framework (Gläser & Laudel, 2013).

The qualitative content analysis was conducted with the mixed-methods analysis software MAXQDA (Version 2022.1). A database was created that contained all documents and interview transcripts for the six case study municipalities. The coding and analysis of the database were then based on the main terms and questions in the evaluation matrix.

3.2.1 Scoring system

For Phase 1 of the overall research, a balanced scorecard was created that was identified as the best approach to communicate the evaluation results. The balanced scorecard was created primarily by identifying measures (i.e., indicators) and assigning weights (Scholey & Schobel, 2018 pg. 12). When identifying the measures, it was important to understand the difference between leading and lagging scorecard measures. A leading measure is defined as predicting future performance, whereas a lagging measure reports on the past (Scholey & Schobel, 2018, pg. 12). For the current research, most of the outcome stream indicators are lagging measures. However, measures related to the outcome streams of ecosystem rehabilitation and restoration, as well as service delivery, are leading measures—they focus on future actions. The assigned weights were equal across all measures or indicators.

Indicator values were then scored using a five-point colour-coded scoring system. This colour-coded scoring system defined how well each municipality is performing within the outcomes streams in comparison to the indicator thresholds. For example, while a municipality

may have some progress within the stream of service delivery, they are not automatically awarded a good score. Instead, their level of performance is assessed relative to the indicator threshold. Hence, the colour-coded scoring system is directly linked to the evaluation matrix and the qualitative content analysis, while ensuring the evaluation results are readable and user-friendly (Abbott et al. 2007 pg. 651). Each colour code (Figure 2) signifies a range of indicator variable values, which is useful since in most cases the data is not being quantified based on the number of codes marked, but rather on the qualitative information contained within the codes and coded text segments.

The colour codes are defined as follows. If a municipality reached a maximum or exceeds the indicator benchmark defined by the evaluation matrix, it received a dark green or light green score, for excellent and good performance, respectively. A yellow, orange, or red score was given if the municipality shows limited or poor performance relative to the indicator benchmark. A grey score was given when there was no information for the indicator and data could not be collected.

Aggregate Benchmark Scoring ex. AC3Q1 – Public Awareness

61-80% of information materials describe one reason for conducting MNAM

21-40% of information materials describe one reason for conducting MNAM

81-100% of information materials describe one reason for conducting MNAM

41-60% of information materials describe one reason for conducting MNAM

0-20% of information materials describe one reason for conducting MNAM

Inconclusive – not enough data

Figure 2. Example of a balanced scorecard (Mollame and Drescher, 2021)

3.3 Rigour

Rigorous research is necessary to ensure that results produced from the evaluation are accurate and reliable (Bengtsson, 2016). To ensure rigour within a program evaluation, the following needs to be considered (Mitchell & Berlan 2016, pg. 247):

(i)   Evaluation is a priority for the organization,

(ii)   Supportive organizational culture exists,

(iii)   Management requires evaluation, and

(iv)   Evaluation is not motivated by personal interest.

Hence, strategies for rigour must be built into the methodological process (Morse et al., 2002). Rigour ensures the validity of the qualitative research approach, as well as whether the data

collection and analysis are transparent and consistent with best practices (Long & Johnson, 2000, pg. 31).

The first approach used to ensure rigour was through triangulation. Content triangulation is the degree that the entire phenomenon under investigation is addressed using multiple data resources (Long & Johnson, 2000, pg. 31-32). Content triangulation was defined through the literature that explores the importance of program evaluation for municipal natural asset management. Next, criterion-related triangulation was defined as the use of various tools to establish a standard. This was achieved using several tools, including the framework design, a program logic model, and an evaluation matrix. Lastly, construct validity is defined as the consideration of the proximity of the tool to the phenomenon in question (Long & Johnson, 2000, pg. 31-32). This final form of triangulation was pursued by the use of the balanced scorecard that combined various qualitative analysis measures to provide a comprehensive scoring system. The research approach effectively utilized various research methods that ensure research rigour (Long & Johnson, 2000, pg. 35).

Another strategy that was used to ensure rigour was peer debriefing. Debriefing within the current research was through the evaluation of research questions through the interview process. Given the definition of debriefing, which is to explore the research results and conclusions with other colleagues, the process of data collection was shared between the researcher, their supervisor, and NAI staff to ensure the researcher and stakeholder-based rigour (Holloway & Wheeler, 1996, pg. 165). This ensured that additional perspectives were applied throughout the processes of data collection and analysis and prevented a singular perspective to bias the process (Long & Johnson, 2000, pg. 34).

The final approach used to ensure research rigour was related to the coding of the text data. With document data collected and the interviews and initial transcriptions completed, the two data streams were compared by the interviewer to ensure that all nuance was captured through a comparative analysis before the datasets. Then, all themes that emerged from the text coding were compared to findings from the literature review to ensure that the results from the current research were properly situated in the context of prior research.

3.4 Limitations of the methodology: subjectivity

Subjective bias is a concern when coding and analyzing the data. Efforts were made to mitigate the potential influence of subjective bias by employing an effective evaluation design. Quantitative indicator variables are a way to limit subjectivity but not all indicators and benchmarks were quantitative, thus raising the issue of subjective bias. However, it is important to note that for qualitative evaluations subjectivity is common. Judgements by the evaluator are needed in program evaluation, such as the identification of relevant program variables and weighting of indicator variables (Bamberger et al., 2012, pg. 137)

All evaluated data were scored at the discretion of the evaluator, which involved the interpretation of the indicator variables and the comparison of indicator measures to benchmarks. In an attempt to reduce subjectivity, the scorecards for the individual municipalities were compared to ensure consistency. Subjectivity was further reduced through the interview process, where the document review results were assessed for accuracy by municipal staff. This ensured that the evaluator was reviewing all relevant documents and correctly interpreted the specific language used by each municipality. Lastly, subjectivity was also reduced through the comparison of Phase 1 data with the data collected in Phase 2. This approach ensured that the data being measured were consistent across the phases.

However, some level of subjectivity cannot be avoided, as the interpretation of patterns deduced from the data is decided by the evaluator. Discussion of these patterns, their enablers and challenges, and the next steps that the evaluator believes will be beneficial to the progress of the case study municipalities in their NAM efforts are presented in Chapter 6. This element of subjectivity is common and unavoidable in program evaluation, as individual evaluators may choose to emphasize different measures to focus on the most relevant information (Ittner et al., 2003).

3.5 Ethical considerations

Part of the current ethical issues considered may arise because of the research (Creswell & Cresswell, 2018). The current research aims to illustrate a relationship between research and practice, thus leading to a mutually beneficial outcome. This effect can be defined through the practice-oriented model, where the researchers or evaluators describe a specific planning problem seen within the practice and develop an innovative approach to understanding or solving the problem (Farthing 2016, pg. 181). In the case of the current research, the approach taken to solve the identified problem is one of program evaluation. The act of program evaluation has its standards of ethics, often consistent with the rules set by an institution or organization. The current research considered the ethical standards set by the Canadian Evaluation Society (CES). The CES defines their standards through the following (Yarbrough et al. 2011; Seasons 2021, pg. 133):

- Competence: the ability of the evaluator to design and perform the evaluation.
- Integrity: ensuring privacy, confidentiality, and anonymity.
- Accountability: respectful and positive client relations.

Given these standards, the evaluator must be aware of the requirements and processes necessary to complete the evaluation (Yarbrough et al. 2011; Bamberger et al. 2012). The current research considered these standards in the program evaluation framework through careful assessment of the ethical implications and open communication with the subjects of the study.

The study involved interviews with municipal staff. Before the study was started, a review by an ethics research board ensured that the researcher considered the potential risks created by the research. A major risk was the possible identification of municipal staff as a result of their participation in the interviews, which may be a social risk. This risk could result in the loss of privacy, reputation, and control of information. The ethics research board required that all municipality staff were made aware of this risk. This process consisted of obtaining informed consent from the participants which consisted of providing participants with an information letter, interview questions, and any additional information they might request. When proceeding with interviews, oral or written consent was obtained, and participants were informed they could withdraw from the study at any time as stated in the information letter. Furthermore, study participants were informed of the risks associated with using an online telecommunications platform. No internet transmissions can be guaranteed as completely secure, and this was made transparent before the interview proceeded. Once the document review and the interviews were completed, all data was securely stored within a locked database. All personal identifiers within the data were removed and no direct quotations are used in the reporting of this study. The University of Waterloo Research Ethics Board approved this study and its data collection procedures under the ethics file number #44360.

With all ethical considerations in place, once the thesis is submitted all results will be shared with the participating municipalities. The shared results and individual scorecards will

provide understanding for municipalities on their progress within NAM. Additionally, they can compare their results with other participating municipalities. This will also serve as gratitude to the participating municipalities.

Chapter 4: The Case Study Municipalities

4.0 Introduction

This chapter provides an overview of each of the case study municipalities that were evaluated as a part of this research. The chapter provides a background on all case study municipalities, including their geographic, demographic, and planning context. Furthermore, the chapter provides background on the NAM pilot projects that were undertaken by these municipalities, as a result of their partnership with the NAI. Description of the case study municipalities includes illustrations using maps to display their location and the geographic makeup of their existing natural assets. All case study municipalities are included in NAI's Cohort 2 (Mollame and Drescher, 2021).

4.1 Case studies in British Columbia

The first set of municipalities evaluated are from the Province of British Columbia (BC). The Province of British Columbia does not have any direct policies or legislation surrounding NAM. However, the municipalities are required to engage in asset management reporting, supported by the Asset Management BC (2019) initiative, a framework for service delivery that details the importance of natural assets. Given this context, the municipalities of Sparwood and Courtney have carried out a pilot NAM project with NAI.

4.1.1 District of Sparwood

The District of Sparwood is located east of Vancouver bordering the Province of Alberta. The municipality falls within the regional district of East Kootenay (Figure 3). Sparwood is one of the highest-elevation towns in Canada and has a history of coal mining in the Elk Valley area (DSW, n.d.). As of 2021, the population of the town was 4,148, showing a 9.6% increase from 2016 to 2021 (Statistics Canada, 2020, 2021a). Despite the small population, the municipality

has grown at a steady rate, increasing housing development and usage of services such as water treatment and waste collection. The municipality is currently located within five provincially protected areas: Crowsnest Park, Elk Valley Park, Morrissey Park, Mount Fernie Park, and Top of the World Park (State of the Basin, 2020). The municipality has a strong focus on the natural environment as a result of its geographic location, where watercourses and waterbodies are often placed under stress due to erosion and sediment pollution. The project undertaken by the District of Sparwood has been evaluated based on several municipal documents, some of these include the following:

- Community Profile (2022)
- Community Official Plan (2022)
- Community Sustainability Plan (2009)
- Community Asset Management Plan (2021)
- Annual Financial reports (2020-2023)
- NAI Summary and Technical Inventory reports (2019)
- Climate Change Action Site (n.d.)
- Parks and Trails Bylaw 1217 (2020)
- Council Notes (n.d).

The review of the documents suggests that Sparwood has made significant progress within their NAM initiatives since the completion of their pilot project. Sparwood was not formally interviewed.
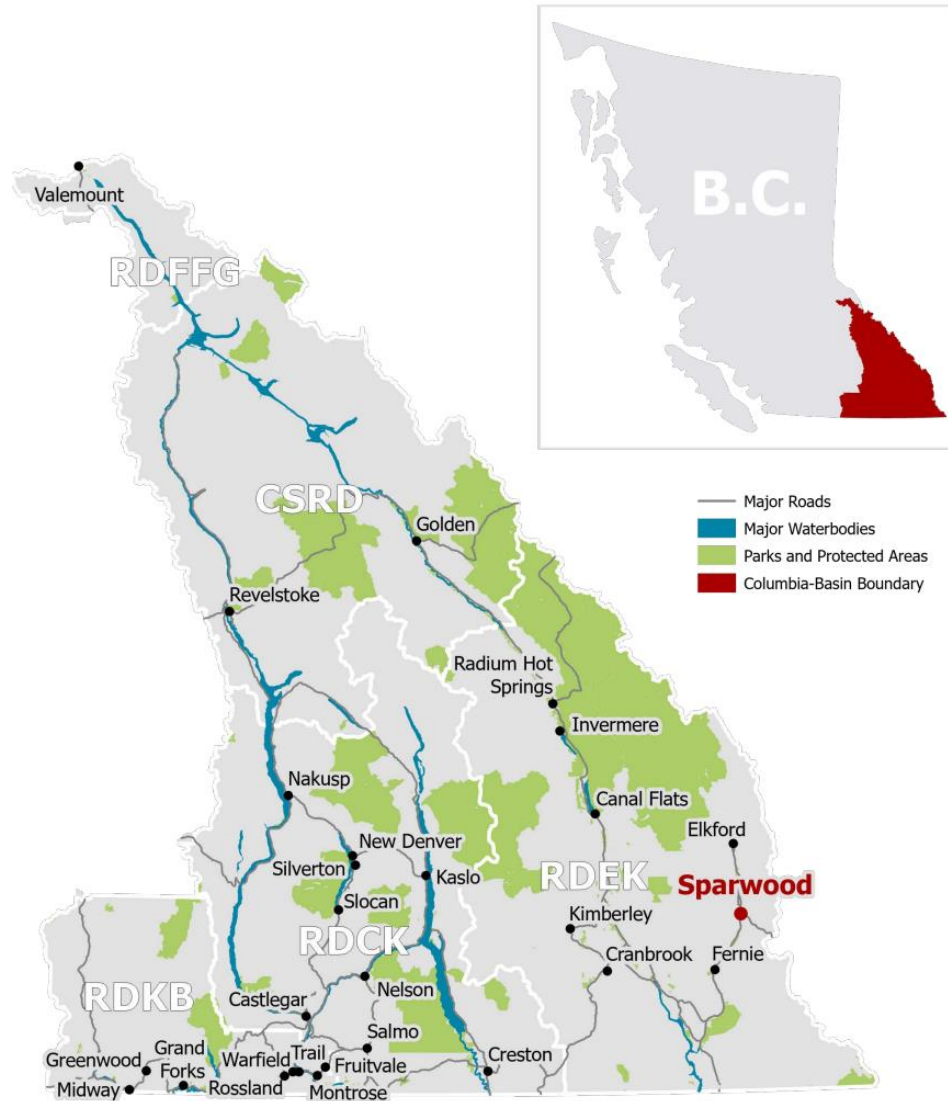
Figure 3.Sparwood concerning the greater region (State of the Basin, 2020).

The NAI pilot project was undertaken within the area of the Sparwood Proper, the lower region of the District of Sparwood (NAI, 2020a). The project focused on the waterbodies within that area, specifically a pond that is known as a storm outlet immediately downstream of a developed sub-catchment from where it receives overflow runoff. The water of the sub-catchment that is caught by the pond slows the flow of stormwater runoff. It is also assumed that the adjacent forest filters and slows the stormwater flows and prevents sediment from entering the Elk River. The NAI pilot was undertaken to evaluate how effective the pond and the

surrounding forest are at capturing the sediments. The results of the pilot indicate that the

existing pond removes approximately 90% of sediments annually. An engineered asset with a

similar function would cost the municipality $248,000 annually in capital and maintenance costs

over 25 years.

4.1.2 City of Courtenay

The City of Courtenay is located on the east coast of the central Vancouver Island region. The

community is located on the traditional land of the K'ómoks First Nation (City of Courtenay,

2022). The municipality is well known for its tourism industry with several attractions for

recreation in Comox Valley. As of 2021, the population was 28,420. The city saw an increase of

10.8% from 2016 to 2021 (Statistic Canada, 2021b). With a growing population and a strong

emphasis on natural recreation lands, the city has various initiatives to protect the natural

environment (figure 4), which includes a focus on reducing greenhouse gas emissions and

several environmental policies for land management. The partnership with NAI is the first

initiative of the city in natural asset management. This project undertaken by the District of

Sparwood has been evaluated based on the following publicly available documentation found:

- Asset Management Policy (2015)

- State of the Environment Report (2014)

- Climate Action Survey (2015)

- Strategic Priorities (2021-2022)

- Tree Protection By-law (2020)

- Urban Forest Strategy (2019)

- Asset Management By-law (2019)

- Energy Feasibility Study (2013)

- Official Plan (2022)

- Corporate Climate Action Strategy (2009)

- NAI Report and Summary (2020)

- By-law 2494 Environmental Development (2019)

The review of the documents suggests that Courtenay has made significant changes to their policies and plans. Courtenay was not formally interviewed.
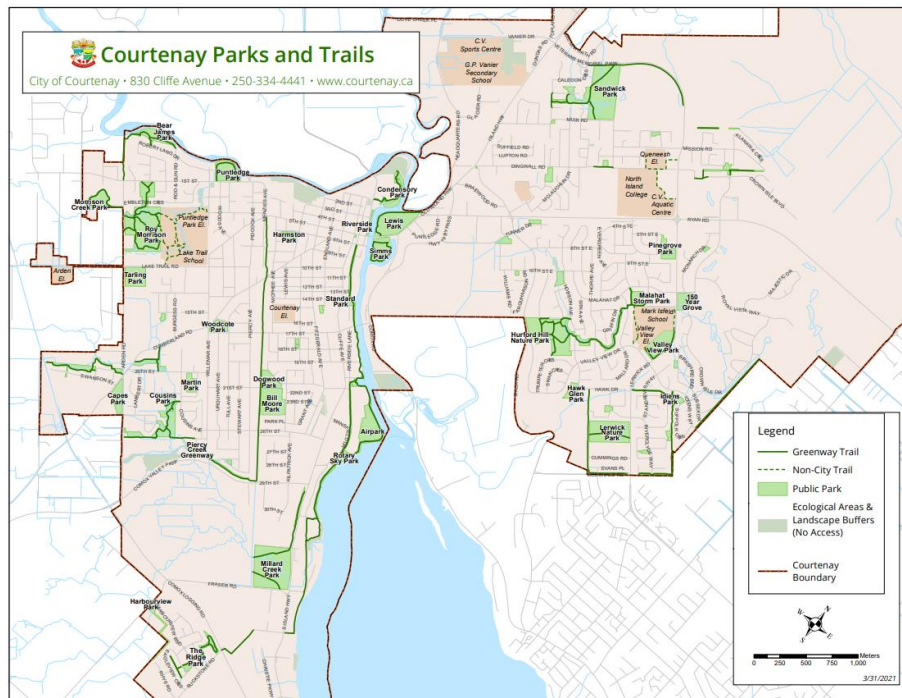
Figure 4.City of Courtenay Parklands (City of Courtenay, n.d).

The NAI pilot project was undertaken on a flood plain located within an estuary around the city (NAI, 2020b). The Tsolum and Puntledge Rivers converge into the Courtenay River, which flows into the estuary. The areas around this estuary are zoned as flood plains that are subject to riverine and tidal flooding at different times of the year. A majority of the development within the city has occurred within or around these floodplains. Hence, the goal of the NAI pilot project was to understand the current and future role that the Courtenay River plays

in the mitigation of the flooding risk for the developments on the flood plains. The project involved scenario modelling of different types of flooding risk and found that natural assets within the area cannot alone solve the flooding problems. However, the improvement of this river corridor could reduce potential flooding damage by between $723,000 and $2.4 million. Additionally, the relocation of at-risk buildings would cost approximately $6.8 million.

4.2 Case studies in Ontario

Within Ontario, municipalities report on asset management as regulated through Ontario regulation. O. Reg. 588/17. The regulation calls for all municipalities to implement an asset management plan by July 2023. This regulation is centered around grey infrastructure assets but there is increasing emphasis on green infrastructure, as defined by the regulation as existing natural systems or infrastructure consisting of human-made services that provide ecological and hydrological functions. This is an all-encompassing definition that considers natural and engineered green assets. Given this context, municipalities such as the City of Oshawa and the Region of Peel are shifting their asset management focus to integrating natural assets.

4.2.1 City of Oshawa

The City of Oshawa is located along the north shore of Lake Ontario. The city is the largest urban municipality within Durham Region and is located east of the City of Toronto (City of Oshawa, 2022a). As of 2021, the city had a population of 175,383, a 10% increase from 2016 to 2021 (Statistics Canada, 2021c). While the city has a primary focus on diversifying its economy, the role of natural assets is seen through social and recreational benefits. The city has several robust natural assets, such as the lake shore and the conserved watershed, that are monitored in partnership with the Central Lake Ontario Conservation Authority (Figure 5). The partnership with NAI is the first initiative in natural asset management for the city. This project undertaken

by the City of Oshawa has been evaluated based on the following publicly available documentation found:

- The Port of Oshawa Land Use Plan (2021)

- Oshawa Strategic Asset Management Policy (2019)

- Durham Community Climate Plan (2016)

- Oshawa Environmental Advisory Committee TOR

- Zoning by-law No. 60-94 (2021)

- Tree By-laws amendment (2021).

- Official Plan (2022)

- NAI Pilot Summary Report (2020)

- Municipal Comprehensive Review: City Comments on the Region of Durham's Proposed Policy Directions Report (2021).

- Oshawa Asset Management Plan (2016)

- Strategic Action Plan (2011)

- Oshawa Environmental Advisory Committee Environmental discussion paper (2019).

The review of the documents suggests that Oshawa has made some progress within their NAM initiatives post completion of the pilot project. There was a formal interview conducted for the City.
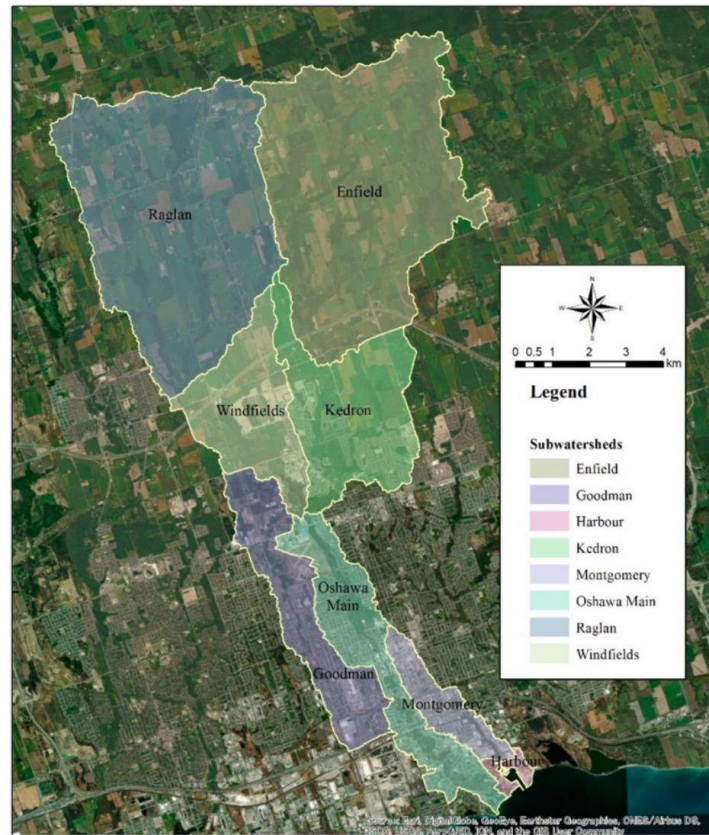
Figure 5. The Oshawa Creek Watershed. (CLOCA, 2023.)

For the City of Oshawa, the NAI pilot project was implemented for Oshawa Creek, which is located south of the city's downtown (NAI, 2020c). This area was selected due to the increase in erosion as a result of stronger rain events within the city. The pilot project explored the current water quality status and resilience of the riparian area and banks alongside the river. Furthermore, the project explored how the existing natural services could be increased. The project produced an inventory of the existing watershed and used the data to carry out erosion modelling to determine the current and potential future capacities of said natural assets. The project findings indicate that the natural assets along the river provide a stormwater management value of $18.9 million. Replacing the existing assets with engineered assets would reduce the current ability to retain water within the river, resulting in more flooding downstream.

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4.2.2 Region of Peel

The Region of Peel is a regional municipality located west of the city of Toronto. Within the

Region, there are three major urban centres: The City of Mississauga, the City of Brampton, and

the Town of Caledon (ROP, 2022a). The region is located alongside Lake Ontario and falls

within the jurisdiction of Credit Valley Conservation, a local conservation authority (Figure 6).

In 2021, the population of the region was 1,451,022, a 5.0% increase from 2016 to 2021

(Statistics Canada, 2021d). The region is committed to climate change solutions in its land-use

planning. Additionally, in line with provincial regulations, the region is integrating natural assets

with their current asset management practices. The NAI pilot project is one of many partnerships

to improve their resilience against climate change impacts. This project undertaken by the Peel

Region has been evaluated based on the following publicly available documentation found:

- Asset Management Plan (2021)

- Business Case for Natural Assets in the Region of Peel: Benefits to Municipalities and
  Local Communities (2020)

- Climate Change Plan (2020)

- Natural Systems in Peel Region Vulnerability Report (2017)

- Water Infrastructure Systems in the Region of Peel Vulnerability Report (2017)

- Municipal Natural Assets Initiative: Region of Peel Pilot (2018)

- Peel Region Official Plan and Review Comments (2021)

- Corporate Asset Management Plan (2021)

- NAI Report (2021)

- Official Plan (2022)

The review of the documents suggests that Peel Region has made some progress within their

NAM initiatives post completion of the pilot project. The Region of not interviewed.
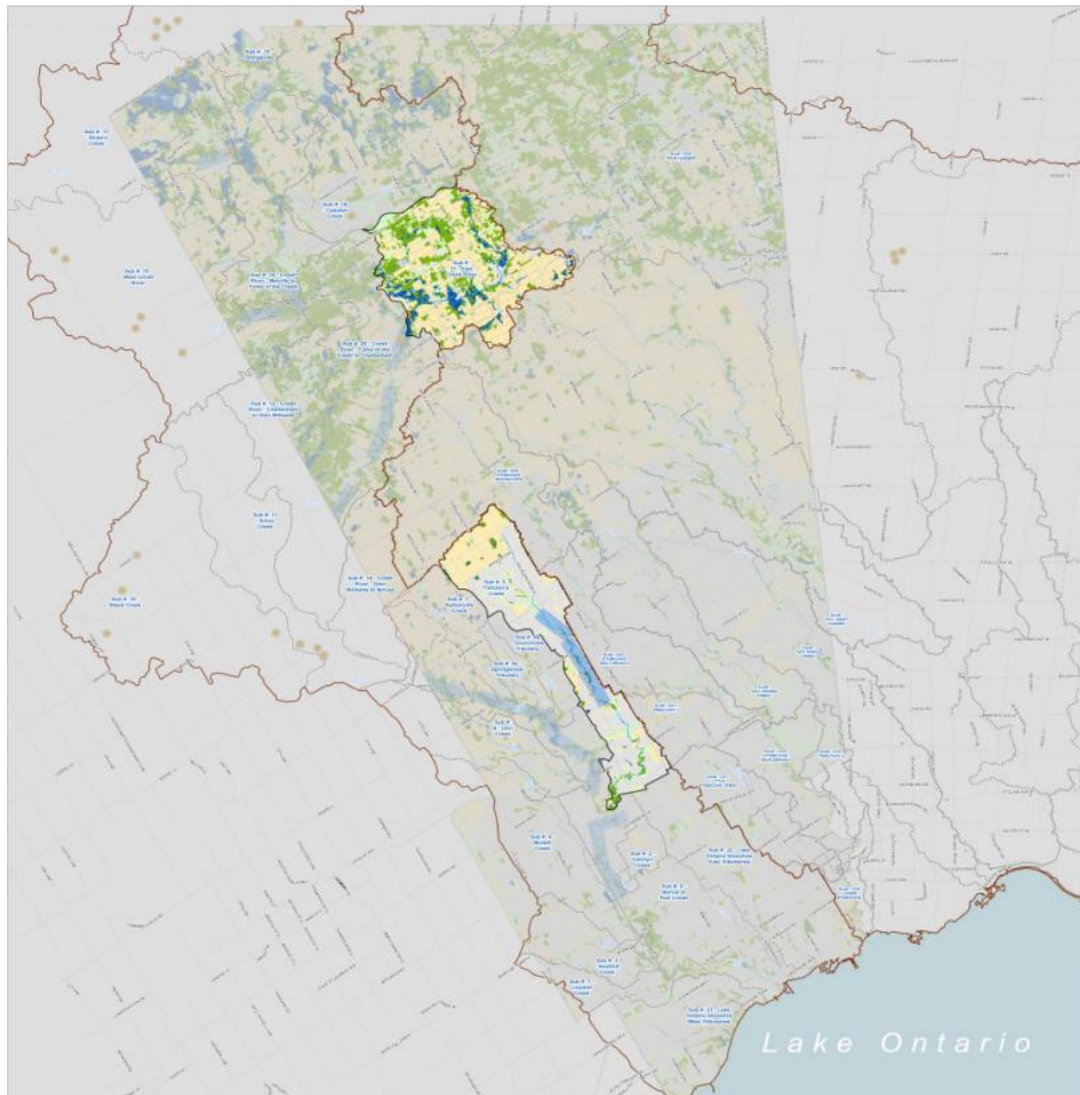
Figure 6.The Region of Peel study area (highlighted) within the watershed (NAI, 2018)

For the Region of Peel, the NAI pilot project was done within the Credit River Watershed

(CRW) (NAI, 2018). The CRW is approximately 1,000 km^2 and consists of 22 different sub-

watersheds. The project was undertaken with the partner organization Credit Valley

Conservation Authority (CVCA). The purpose of the pilot project was to value the stormwater

impacts of CRW on flooding and erosion within the region. The project results suggest that the

CRW's retention of excess water and the prevention of flooding after a 100-year return period

storm exceeds the provincial requirements for water quality. The value of this natural system

compared to engineered services could cost an estimated $704 million (or $764 million under

projected climate change conditions). Since the initial project in 2017, the Region of Peel has

created a robust inventory of stormwater services across the entire region.

4.3 Case studies in New Brunswick

As of 2017, the Province of New Brunswick has an established asset management plan

for the management of grey and engineered assets (DELG, 2017). Before this plan, the province

had an established Environmental Management Manual (2010). The asset management plan

focuses on interpreting the federal environmental policies as relating to the province's natural

assets such as watercourses, wetlands, and shorelines. Additionally, as of January 1st, 2023, the

province has reformed its municipal structure. The reform has amalgamated all pre-existing

municipalities into nine districts (Province of New Brunswick, 2023). The information about the

municipalities of the Town of Florenceville-Bristol and the Southeast Regional Service

Commission addresses their structure before these political changes and at the time of the NAI

pilot project implementation.

4.3.1 Town of Florenceville-Bristol

The Town of Florenceville-Bristol is a thriving community located in the western region

of New Brunswick, Canada. The town, as of 2021, had a population of 1,573, which is a 1.9%

drop in its population from 2016 (Statistics Canada, 2021e). The town is surrounded by several

natural assets, such as the Saint John River, and agriculture is the primary industry. The town is a

part of the Northwest Regional Service Commission and has recognized the importance of

natural asset management alongside traditional infrastructure. With the ongoing damage caused by frequent and intense rainstorms along the St. John River, the town realized the need to manage natural assets, such as forests, to reduce or prevent flooding and control erosion (Figure 7). The project undertaken by the Municipality of Florence Ville Bristol has been evaluated based on the following publicly available documentation found:

- By-law No.13b – Infrastructure (2020)

- By-law No.20 Public Spaces (2020)

- Climate Action Plan (2020)

- Gov of NB Environmental Trust (n.d.)

- NB Local Saving Program (n.d.)

- NAI Summary and Inventory (2018)

- Partners of Climate Protection (n.d.)

- Strategic Plan 2017-2020

The review of the documents suggests that no work has been done since the pilot project. No formal interviews were conducted as the municipality expressed that they had not done more work since their NAI pilot.
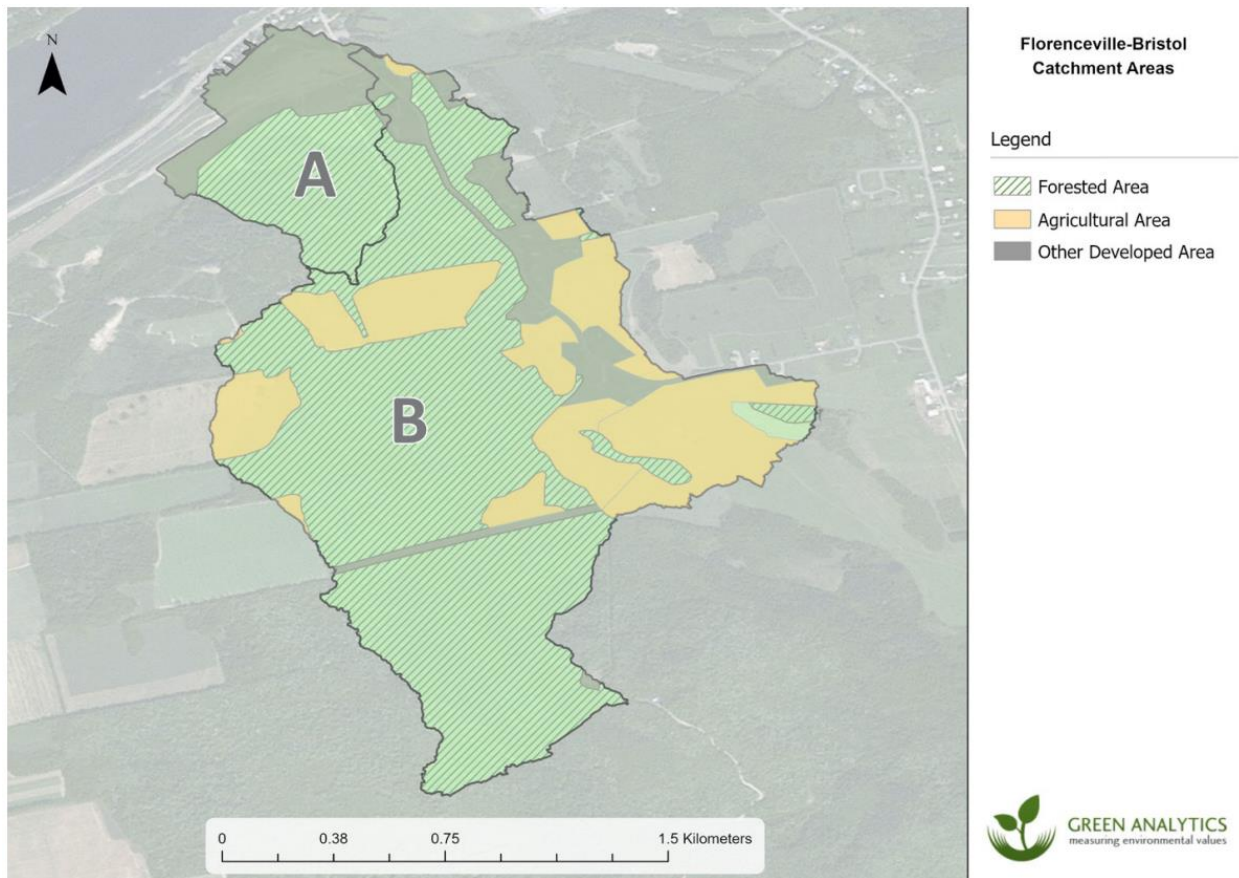
Figure 7. Florenceville-Bristol catchment areas (NAI, 2021).

The pilot project within the town was undertaken as a partnership between the Western

Valley Regional Service Commission, the World Wildlife Fund Canada, and Florenceville-

Bristol (NAI, 2021). The Florenceville-Bristol project aimed to evaluate the impact of surface

condition changes in the upper watershed on peak flow levels, while also considering changing

climate conditions. The project investigated two scenarios: the first assessed peak flow rates

under existing conditions at three storm return periods: a 5-year storm, a 100-year storm, and a

100-year storm +20%. The second scenario evaluated peak flow rates assuming a shift in land

cover from forest to agriculture in the upper watershed under the same three storm return

periods. The project resulted in two scenarios that examined flood and stormwater flows in

predominantly forested watersheds, showing that the forests are providing a value of $3.5 to $4.1

million in stormwater management services. Developing a natural asset management plan will help protect and enhance the stormwater service for the long term.

4.3.2 Southeast Regional Service Commission (SERSC)

The Southeast Regional Service Commission (SERSC) is one of twelve regional commissions within the Province of New Brunswick. The SERSC was created in 2013 to aid communities with regional communication and infrastructure projects (SERSC, 2023) and is responsible for managing shared services such as land development and waste management. The Southeast Regional Service Commission covers Westmorland and Albert counties, situated in the Southeastern area of New Brunswick that borders the Bay of Fundy, Northumberland Strait, and Nova Scotia (SERSC, 2023). This recently established Regional Service District comprises two cities, three towns, nine villages, one rural community, and 24 local service districts, making it the most populous region in New Brunswick (Figure 8). The three cities in the Commission's area are Riverview, Riverside-Albert, and Pointe-due-Chene. Given the regional responsibility of land use planning, SERSC has been responsible for implementing NAM pilot projects for several municipalities within the region. This project undertaken by the SERSC has been evaluated based on the following publicly available documentation found:

- SERSC
    - Annual Reports (2013-2021)
    - Annual Budgeting Reports (2013-2020).
    - Rural Tantramar Climate Change Adaptation Plan (2021)
    - WESTMORLAND-ALBERT RURAL PLAN (2022)
- Riverview
    - Annual Reports (2019-2021)

- o Active Transportation Plan (2013)

- o By-law Report no. 300 (n.d.)

- o Economic Development Strategy (2012)

- o Community Sustainability Plan (2015)

- o Mill Creek Plan (2013)

- o Strategic Plan (2021-2026)

- o NAI Summary and Technical Report (2020)

- Riverside-Albert

  - o NAI Summary and Technical Report (2021)

  - o Village Of Riverside-Albert Municipal Rural Plan By-Law (2017)

- Pointe-du-Chene

  - o NAI Technical Report (2021)

The review of the documents suggests that while work is being done regarding climate change adaptation and environmental protection within the region, no specific work is be done in relation to the NAM pilots. Informal Conversations with staff in the region suggest that many of these communities are significantly limited by their limited staff and resources.
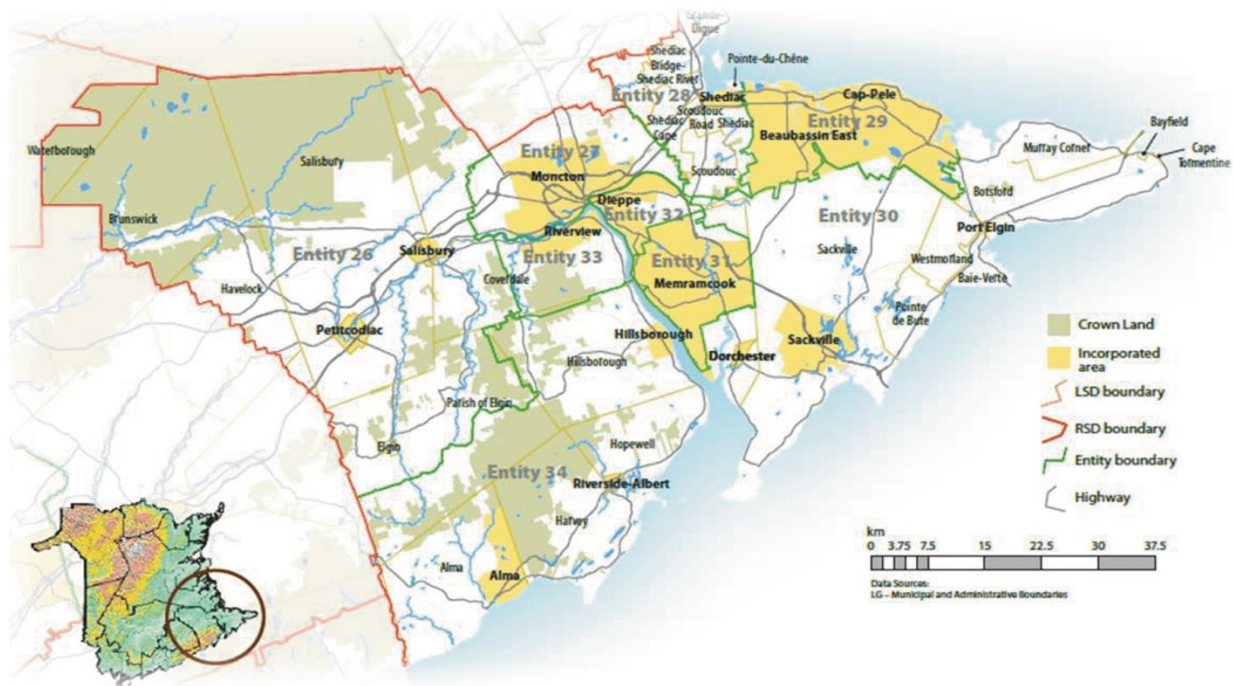
Figure 8. The Southeast Regional Service Commission. (Brucewack, 2022)

The pilot projects within the region are in partnership with NAI and are led by the commission's planning department, referred to as PLAN360. The department is responsible for all environmental and climate change planning and projects, emphasizing the benefits of ecosystem services. PLAN360 collaborated with the NAI and local stakeholders to implement three pilot projects aimed at promoting natural asset management in the region (SERSC, 2020):

- In Riverview's Mill Creek, the project aimed to identify crucial natural assets that offer flood reduction services within the watershed.

- Riverside-Albert depends on a steady surface water flow provided by the Arabian Vault Brook watershed to meet the community's municipal water supply requirements.

- Pointe-du-Chêne is a coastal community that is susceptible to flooding, with the vulnerability increasing with rising sea levels.

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Chapter 5: The Results

5.0 Introduction

This chapter provides the evaluation findings that follow from the document reviews and the interviews conducted for each case study municipality and is organized according to the four outcome streams in the program logic model. The findings are presented using a five-point colour-coded summary scorecard, comprising six individual scorecards, to depict the scores assigned to each municipality for the evaluated indicators (Figure 9). The summary scorecard has been created to allow comparison between the municipalities, outcome streams and indicators, as well as for pattern identification.
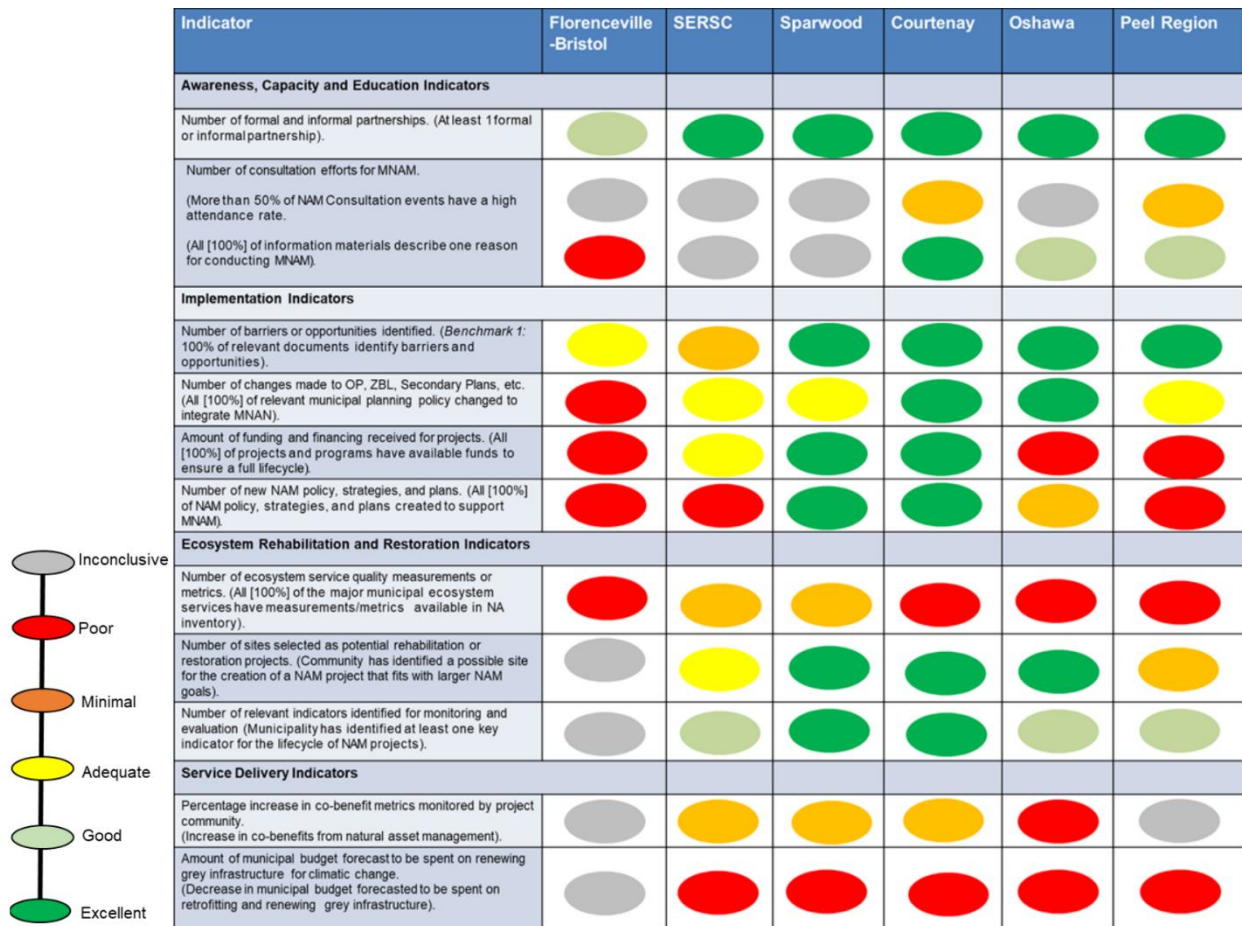
Indicator	Florenceville-Bristol	SERSC	Sparwood	Courtenay	Oshawa	Peel Region
Awareness, Capacity and Education Indicators						
Number of formal and informal partnerships. (At least 1 formal or informal partnership).	Good	Excellent	Excellent	Excellent	Excellent	Excellent
Number of consultation efforts for MNAM. (More than 50% of NAM Consultation events have a high attendance rate.	Inconclusive	Inconclusive	Inconclusive	Minimal	Inconclusive	Minimal
(All [100%] of information materials describe one reason for conducting MNAM).	Poor	Inconclusive	Inconclusive	Excellent	Good	Good
Implementation Indicators						
Number of barriers or opportunities identified. (*Benchmark 1:* 100% of relevant documents identify barriers and opportunities).	Adequate	Minimal	Excellent	Excellent	Excellent	Excellent
Number of changes made to OP, ZBL, Secondary Plans, etc. (All [100%] of relevant municipal planning policy changed to integrate MNAN).	Poor	Adequate	Adequate	Excellent	Excellent	Adequate
Amount of funding and financing received for projects. (All [100%] of projects and programs have available funds to ensure a full lifecycle).	Poor	Adequate	Excellent	Excellent	Poor	Poor
Number of new NAM policy, strategies, and plans. (All [100%] of NAM policy, strategies, and plans created to support MNAM).	Poor	Poor	Excellent	Excellent	Minimal	Poor
Ecosystem Rehabilitation and Restoration Indicators						
Number of ecosystem service quality measurements or metrics. (All [All] [100%] of the major municipal ecosystem services have measurements/metrics available in NA inventory).	Poor	Minimal	Minimal	Poor	Poor	Poor
Number of sites selected as potential rehabilitation or restoration projects. (Community has identified a possible site for the creation of a NAM project that fits with larger NAM goals).	Inconclusive	Adequate	Excellent	Excellent	Excellent	Minimal
Number of relevant indicators identified for monitoring and evaluation (Municipality has identified at least one key indicator for the lifecycle of NAM projects).	Inconclusive	Good	Excellent	Excellent	Good	Good
Service Delivery Indicators						
Percentage increase in co-benefit metrics monitored by project community. (Increase in co-benefits from natural asset management).	Inconclusive	Minimal	Minimal	Minimal	Poor	Inconclusive
Amount of municipal budget forecast to be spent on renewing grey infrastructure for climatic change. (Decrease in municipal budget forecasted to be spent on retrofitting and renewing grey infrastructure).	Inconclusive	Poor	Poor	Poor	Poor	Poor

Legend:
- Inconclusive (grey)
- Poor (red)
- Minimal (orange)
- Adequate (yellow)
- Good (light green)
- Excellent (dark green)

Figure 9. A summary scorecard for the six case study municipalities.

5.1 Awareness, education, and capacity indicators

5.1.1 Capacity and partnership indicator

For the capacity indicator, the majority of municipalities obtained an excellent score, with more than one partnership with an academic institution, relevant non-governmental organization, or private landowner. Additionally, this indicator captures municipal collaborations with provincial organizations and conservation authorities (or equivalent organizations outside of Ontario). These kinds of collaborations can be found more often in smaller municipalities, as they tend to work closely with other government organizations to provide a variety of natural asset-based programs. Whereas a majority of the recorded partnerships are not directed towards natural asset management, they indirectly benefit the progress of natural asset management within the municipalities. Many partnerships focus on climate change mitigation and adaptation, result in projects and funding for green infrastructure or nature-based solutions, and indirectly support natural asset management within the municipalities.

Town of Florenceville-Bristol

The Town of Florenceville-Bristol (FVB) in New Brunswick has made valuable efforts to establish partnerships in the community. The majority of the partnerships noted on the municipality's website are with provincial organizations or are provincially funded. Some examples of this are the municipal partnership with the Province of New Brunswick Local Savings Program, an energy savings program for residents (FBV, 2017a). The municipality also has partnerships with businesses and local individuals, through the established program *Partners of Climate Protection* which is funded by the Province of New Brunswick (FVB, 2017a). This program is offered by the municipality to residents and businesses as a way to increase

awareness of their climate change plan and support individual efforts to protect the local environment.

Although this indicator primarily recorded partnerships with non-governmental organizations, the small size and population of the town suggest that the majority of their operations are enabled through provincial support. Given this, FVB has been awarded a good score for the partnerships indicator. While the municipality may be limited by its small size and limited resources, they have attempted to involve the local community within its natural asset management practices, programs, and projects. Overall, the Town of Florence Ville Bristol is doing good work with their limited partnerships.

Southeast Regional Service Commission

The structure of the Southeast Regional Service Commission (SERSC) in New Brunswick, and the region's municipalities bring a challenging element. As noted in Chapter 4, while the NAI projects were performed by SERSC, the case study's municipalities are Riverview, Riverside-Albert, and Pointe-du-Chene (SERSC, 2023). Thus, when considering partnerships, a combination of municipal and regional partnerships was considered. Given this, the majority of the work done by the three municipalities was in collaboration with the region. The municipalities themselves have limited resources and staff to carry out operations. This implies that the majority of work done within SERSC is at the regional level.

Conversations with SERSC staff suggest that the majority of partnerships that concern natural asset management address efforts of climate change mitigation and adaptation. Similar to FVB, the region of SERSC has many partnerships with government organizations, including the federal government of Canada and the Province of New Brunswick. Some examples of these government partnerships are with Natural Resources Canada and with the Province of New

Brunswick Environmental Trust Fund (SERSC, 2021a). Within the same climate change efforts, as of 2017, partnerships have been formed with Université de Moncton's Engineering faculty, Nature NB, and the Natural Capital Lab, for the research and development of inland flood mapping for the region (SERSC, 2017). These partnerships examine the regional flood plains and produce data that can inform decisions regarding climate change planning. Overall, a combination of government and non-government partnerships suggests that SERSC has done significant work to establish ecosystem-based programs and projects.

Whereas these partnerships are not directly related to natural assets, the regional focus on climate change provides the opportunity to study the local natural assets. Given the variety and focus of these partnerships, the region has an excellent rating for the partnerships indicator.

District of Sparwood

The District of Sparwood in British Columbia (henceforth: Sparwood) has made significant efforts to establish partnerships with the local indigenous and non-indigenous communities. The most notable partnership in Sparwood is with the Ktunaxa Nation (DSW, 2021a; 2022a). Sparwood online web pages provide detail on their annual reporting and their climate change actions. Sparwood has made efforts to involve the local indigenous communities in their climate change policy, noting them as stewards of the land and vital for the understanding of the health of natural assets. Given this, engagement and involvement with the local indigenous nations is seen across various municipal departments, such as economic development and land-use planning. Sparwood also has an established partnerships program known as The Local Government Climate Action Program (LGCAP) with the provincial government of British Columbia (DSW, 2021b). This program, funded by the province, supports Sparwood in the collection of local knowledge and the implementation of climate change

initiatives in its Community Sustainability Plan (DSW, 2009). Overall, Sparwood has more than one notable partnership that is geared towards natural assets and ecosystem services. Sparwood is given an excellent rating for the partnerships indicator.

City of Courtenay

The City of Courtenay in British Columbia (henceforth: Courtenay) has made significant efforts to collaborate with the local community and seek out support from the provincial government. Similar to Sparwood, Courtenay has an established partnership with the Province of British Columbia, resulting in the city's own Local Government Climate Change Program (City of Courtenay, 2022a). This partnership provides funding and resources for Courtenay to effectively progress on its climate change initiatives and encourage resident engagement with repeated climate change impact surveys. Outside of provincial partnerships, the following are community and private landowner partnerships within the city (City of Courtenay, 2021d):

- Courtenay Rotary Club—Rotary Trail & Mile of Flowers: A partnership for trail and wildflower maintenance.

- C.V. Land Trust—Hurford Hill Nature Park: Local land trust partnership for land conservation efforts.

- Lush Valley—Community Gardens: A community partnership that focuses on naturalized and native community gardens and front lawns.

- Lake Trail Neighbourhood Society—Community Gardens: A community partnership that focuses on naturalized and native community gardens and front lawns.

These partnerships are noted by the municipality as advancing their natural asset management, by encouraging the local community to protect and maintain the existing natural assets that are

often utilized for recreation. These partnerships are directly progressing natural asset management in the city while encouraging residential engagement and awareness. Overall, the city itself has five notable partnerships that are geared towards natural assets and ecosystem services. Given the variety and focus of these partnerships, the city is given an excellent score for the partnerships indicator.

City of Oshawa

The City of Oshawa (henceforth: Oshawa) brings an interesting perspective to natural asset partnerships due to the influence of conservation authorities, established semi-governmental bodies that monitor, and value ecosystem services provided by protected natural assets (Government of Ontario, 1990; CLOCA, 2022). In Ontario, municipalities are encouraged to partner with conservation authorities but are not required to do so. Oshawa is currently partnered with the Central Lake Ontario Conservation Authority (CLOCA). This is highlighted in various land-use planning practices, as CLOCA provides valuable feedback for development within and around vital natural assets such as watersheds and forests (CLOCA, 2022).

Oshawa has also established several community partnerships. Some of the most notable partnerships are:

- Communities with Brooms and Community Cleanup is community-based management of litter and pollution that impedes natural systems (City of Oshawa, 2022a).
- Local Enhancement and Protection of Forest (LEAF) is a not-for-profit collaboration that supports the protection of Oshawa's natural woodlands and encourages tree planting and invasive species management (City of Oshawa, 2022b).

- Bee City Canada provides protection and enhancement of native flowers and gardens (City of Oshawa, 2022d).

Although these partnerships are not explicitly noted as natural asset management partnerships, they are supporting existing natural assets within the city. Overall, the city has three notable partnerships that are geared towards natural assets and ecosystem services. Given the variety and focus of these partnerships, the city has an excellent score for partnerships.

Region of Peel

Similar to Oshawa, the Region of Peel (henceforth: Peel) is a regional municipality in Ontario that is establishing partnerships with both conservation authorities and local community groups. The NAI pilot in Peel Region was done in collaboration with the Credit Valley Conservation Authority (CVC, 2023). CVC is responsible for the protection and management of the regional watershed, which is the same as the one evaluated within the NAI pilot. Peel also works closely with the Toronto Conservation Authority (TRCA, 2023) to manage development around ecologically connected landscapes such as the Ontario Greenbelt. Aside from government partnerships, Peel has partnered with not-for-profit organizations such as Climate Connections and Clean Air Partnership to further regional initiatives with a focus on climate change mitigation (ROP, 2022d). These partnerships provide resources to enhance air quality, flood mitigation, and reduce carbon emissions. The Climate Connections partnership has provided monitoring data on the vulnerability of natural systems, highlighting the importance of natural assets within the region since 2012. Overall, Peel has more than one notable partnership geared towards natural assets and ecosystem services. Peel has an excellent score for the partnerships indicator.

5.1.2 Awareness and education

This is inconclusive across all municipalities. In this outcome stream, there is a lack of attendance rates for municipal natural asset management consultation events. Furthermore, it is unclear whether municipalities have conducted consultation events that are specifically for municipal natural asset management projects, policies, or programs. It seems that the majority of municipalities conduct natural asset management consultation that is embedded within other projects or programs. By comparison, the majority of municipalities provide reasons for conducting municipal natural asset management through several municipal documents and online resources. The understanding of municipal natural asset management is different across all municipalities, as it is often correlated to their existing environmental concerns established before their natural asset pilot projects with NAI.

Town of Florenceville-Bristol

The Municipality of Florenceville-Bristol does not collect or publicize data on its consultation efforts concerning environmental projects or natural asset management consultation events. There is little evidence of past consultation efforts by the municipality. However, through their strategic plan and council notes it is obvious that the municipality does emphasize local engagement and community feedback (FVB, 2017b). Their community climate change plan (2020) emphasises that several engagement sessions took place and survey information was collected concerning energy use and general environmental concerns (FVB, 2020). In terms of accessibility regarding natural asset management documentation, the municipality has made several of its documents public, with monthly municipality council hearings taking place live with open consultation.

Conversations with the staffers indicate that no work concerning natural asset management has been done since the pilot; much of their publicly available information is related to general climate change adaptation and individual energy use for community members. Concerning the first indicator, there are no available attendance rates for a score to be calculated. For the second indicator, all information materials that the municipality has produced have only vaguely mentioned the use of natural assets. Given this, a poor performance rating is given. While the municipality does focus on environmental initiatives, they are outside the scope of the pilot project and natural asset management.

Southeast Regional Service Commission

The Southeast Regional Service Commission (SERSC) has not made an effort to engage the public within its natural asset management efforts. There is little evidence of past consultation efforts by the SERSC. In conversations with the staff at SERSC, while there may not be documentation of the consultation and engagement with residents, the municipalities within the region do seek out and utilize the knowledge and feedback from residents. This also suggests that many environmental initiatives are taken on by the community, outside of municipal influence. However, this understanding cannot be confirmed by documentation. Concerning the first indicator, there are no available attendance rates for a score to be calculated. For the second indicator, no consultation materials could be found that indicate the importance and use of natural asset management, thus an inconclusive score.

District of Sparwood

The District of Sparwood (Sparwood) has made minimal effort to engage the public on natural asset management initiatives. Sparwood has an online archive of all their engagement efforts, published on their websites. Sparwood has designated information folders for community

events, public notices, questionnaires and surveys, and construction notices (DSW, 2023a). Within these folders, there is no consultation event that is specific to natural asset management. Additionally, there is no evidence of consultation attendance or community feedback within these folders. These folders simply provide informational material. Similarly, no evidence can be found of the municipality discussing natural asset management in consultation materials. Documentation such as the community profile (2016), the community official plan (2021), and the community sustainability plan (2009) all provide information for conducting natural asset management, outside of consultation efforts (DSW, 2009, 2016, 2021c). Concerning the first indicator, there are no available attendance rates for a score to be calculated. For the second indicator, no evidence of consultation materials discussing natural asset management can be found, thus an inconclusive rating.

City of Courtenay

The City of Courtenay (Courtenay) has an established Engagement Playbook (City of Courtenay, 2019a), that is dedicated to community engagement in consultations enabled by the City of Courtenay Official Plan (City of Courtenay, 2022c). Within this document, Courtenay highlights the importance of public feedback concerning policies put forth by the official plan and changes to the official plan upon review. As a result, Courtenay has publicly accessible hearings and notices that they used to engage with their residents. These public hearings are used to discuss various topics that range from development projects and asset management such as waste and stormwater. Although information regarding the attendance rates of these hearings cannot be found, Courtenay does publicize their consultation materials. In the context of environmental initiatives and natural assets, the city has undertaken the Local Government Climate Change Program since 2015 (City of Courtney, 2022a). This survey was aimed towards

the general public to provide feedback on emerging concerns concerning climate change. Within this survey, questions are aimed towards understanding public knowledge and concerns regarding climate change's impacts on nature. The responses to these surveys are not public.

Outside of the Climate Action Surveys, the municipality has a newsletter that provides updates on the decisions of the Council. Post-implementation of the NAI project has resulted in discussion regarding natural assets, asset management practices, and updating existing asset management policy to reflect natural assets (City of Courtenay, 2023a). These discussions are available online and suggest public involvement but not the numerical presentation of comments. Lastly, the city often compiles notes from past council hearings into a singular document. A document containing the summary of engagement sessions for the draft official plan review provides insight into residents' comments regarding green infrastructure management, such as woodlands, parks, and shorelines (City of Courtenay, 2020a). These efforts suggest that the city ensures that the community is actively involved in natural asset management decisions and projects.

Concerning the first indicator, there are no available attendance rates for a score to be calculated but the variety of informational materials and consultation efforts suggest significant public involvement regarding the natural environment. Therefore, a score of minimal performance was given to show that work public interest in natural assets is present but there is no accurate way to determine that amount of interest. For the second indicator, the document suggests the importance of natural assets can be found across various informational materials produced by the city. Given this, an excellent score is given.

City of Oshawa

The City of Oshawa states that they have a strong focus on community engagement and resident feedback. Oshawa does publicize consultation materials. This is done through their website, Oshawa Connect, an online platform to inform, engage, and collect information from residents (OshawaConnect, 2023). This platform also stores information on various council and committee meetings. A review of council meetings from the years 2019—2023 suggests that while there have been public hearings regarding the update of the City of Oshawa Asset Management Plan (Oshawa Finance Committee, 2021), there is no evidence of consultation specifically for natural assets. However, much of the material surrounding these asset management meetings notes the importance of the natural environment and green infrastructure as an additional focus from the old asset management plan from 2016. No evidence can be found of attendance rates for the council hearing. Furthermore, the information in documents presented to the council and the public during the 2021 review of the Asset Management Plan, including meetings notes, the presentation, and summary documents, which provide information on natural assets by focusing on stormwater management, flooding hazards, and Oshawa's designated natural heritage system area (Oshawa Finance Committee, 2021).

Concerning the first indicator, there are no available attendance rates for a score to be calculated. However, the documentation suggests that the municipality does engage with residents and seek feedback regarding asset management practices. For the second indicator, the documentation suggests the importance of natural systems can be found across various informational materials produced by the city. However, there is no specific use of language such as for natural asset management. Given this, good performance is the rating. While the city

prioritizes and provides reasons for its use of natural asset management, the language used indicates that there is a greater focus on engineered assets.

Region of Peel

The Region of Peel is dedicated to strong community engagement and consultation as noted through their Official Plan (ROP, 2022b). Since the pilot project with NAI in 2017, the region held several consultation events but no specific events for natural asset management projects or programs. The documentation of past events is also not publicly available and only available upon request from an internal archive. However, a recent effort was for the 2051 Official Plan Review, which consisted of 60 consultation events from 2021 to 2022 (ROP, 2022c. Although these events did not particularly focus on natural assets, a major focus area of the plan was climate change and water resources, while proposing a boundary expansion. There is no evidence of the attendance rates or community feedback except for the post-implementation of the plan in 2022 which resulted in 529 public responses. These are stored in the Appendix titled 'RE: 'Reject the Draft Peel 2051 - Grow within the Existing Settlement Boundary', of which 30 responses directly focus on natural asset management within the region and 42 focused on climate change mitigation. The remaining used terms such as urban sprawl and natural heritage to push back against the Peel Region's decision to expand regional boundaries (ROP, 2022b). Notably, the comments focus on the impact of sprawl on declining ecosystems and the loss of ecosystem services. This suggests that while there is limited evidence of natural asset focus consultation, there is a great public interest in natural asset management and ecosystem services within the community. Furthermore, a review of their 2051 Official Plan Review consultation documents and their presentations and reports convey a strong emphasis on the

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natural environment. Primarily the documents consider natural assets as a function of individual municipalities and the conservation authority.

Concerning the first indicator, there are no available attendance rates for a score to be calculated, but there is evidence published by Peel Region that indicates community interest in the natural environment within the region. Therefore, the region is rated as having minimal performance. Documentation suggests that the municipality does engage with residents and seek feedback but has made no notable effort to discuss natural asset management directly. For the second indicator, documentation suggests the importance of natural systems can be found across various informational materials produced by the region, through their review of the official plan. This includes presentations, surveys, and summary reports. Given this, good performance is the rating.

5.2 Implementation outcomes

5.2.1 Barriers and opportunities

All municipalities were able to identify one barrier to municipal natural asset management. The types of barriers and opportunities were diverse. However, there were often similarities amongst barriers. The most common barrier related to program funding and staff limitations. This was particularly true for municipalities that were small in population sizes such as the District of Sparwood or the Town of Florence-Ville Bristol. Opportunities had high variation. The most common theme across municipalities was that natural asset management was an opportunity within itself. Many municipalities note they are revising policies to focus on climate change mitigation and provincial guidance for environmental land use planning.

Town of Florenceville-Bristol

For Florence Ville-Bristol, there are several notable barriers and opportunities that the municipality has defined through their Strategic Plan (2017–2020) with the major barrier being operational risk (FVB, 2017). This risk is focused on the limited experience that municipal staff may have to implement ecosystem-based services such as natural asset management. A practical example of this can be seen through the climate change plan, as the focus on energy saving and sustainable use of resources is a responsibility of the municipality but is supported by the province. These efforts are also placed on individual residents, including education and awareness to allow the community to aid the municipality with completing its sustainability goals and targets. A major reason behind this barrier is that the town is limited by its number of staff and financial resources. For opportunities or other enabling conditions, the Strategic Plan indicates that implementation of natural asset management may be able to progress within the municipality due to (1) increased knowledge of the natural environment, (2) funding through existing climate change initiatives, and (3) updating environmental data (FVB, 2017). Hence, the municipality is rated as having excellent performance (Fig. 3).

Southeast Regional Service Commission

The Southeast Region Service Commission has identified staff and resources as their largest barrier to implementing natural asset management. Communications with the region suggest that given the small populations of their lower-tier municipalities, there is often a lack of municipal staff to implement new initiatives, such as natural asset management. Similarly, given the small size and area of the municipalities, their funding is often limited and based on what the region deems necessary. For example, the Municipality of Riverview is the only municipality that publishes annual reports (Town of Riverview, 2021). These reports indicate that the municipality has few staff members and many core functions of the municipality, such as

emergency services, are run voluntarily. This results in limited exploration of innovative projects such as natural assets management and monitoring.

Communications with the region suggest that the opportunity for natural asset projects is the increasing knowledge surrounding them in general. Given the small size of the lower-tier municipality, NAI partnerships are an opportunity to gain knowledge on natural and engineered assets. Similarly, the region learns from these projects and implements this learning in the other municipalities that they manage. These can be seen with their new Rural Tantramar Climate Change Adaptation Plan (SERSC, 2021b), which focuses on a large area that encompasses several municipalities. This plan has an entire section on asset management within these areas in light of climate impacts. Projects such as these are influenced by the NAI pilots.

As for the score, the region can provide evidence of identified barriers and opportunities; however, much of what is understood about barriers and opportunities cannot be found through document review, as this information is not made public. Hence, they have an adequate rating. The region is encouraged to identify possible opportunities and barriers, especially regarding ecosystem rehabilitation, restoration, and service delivery.

District of Sparwood

A review of Sparwood's documents suggests that the largest barrier to municipal initiatives is their population and resources. The Official Plan suggests that given the small size of the municipality, it is difficult to predict demographic factors that influence economic stability (DSW, 2021a). This impacts the municipalities' ability to function and plan for the future. Furthermore, within the Annual Municipal Reports from 2021 to 2022 (DSW 2021b; 2022c), the council has noted that their two major concerns for land-use planning are the maintenance of the natural environment and the maintenance of existing engineered infrastructure. The council's

support is an opportunity but a lack of resources can limit the municipalities' ability to focus on these concerns. An opportunity that has come from this barrier is the exploration of partnerships. This is true for provincial partnerships regarding climate change, providing resources through funding and grants for environmentally relevant projects. Given the municipality is transparent with its current opportunities and setbacks, they have been excellent for this indicator.

City of Courtenay

The City of Courtney has an active asset management plan and by-laws (City of Courtenay, 2019b). The primary challenge identified by the city is life cycle costs and documentation of the life cycle (Courtenay Council, 2019). The city states that the successful implementation of the bylaws is confounded because new concepts regarding asset management are not found within other policies and plans. This would require an update of all relevant documentation in light of the asset management policy. Furthermore, this review of documents relating to management practices will also require consideration of full life-cycle costs regarding implementation. This is specifically noted as a challenge for engineered assets. New management practices related to monitoring may require more funding.

However, a major opportunity for successful asset management is defined through the use of natural assets themselves. Discussions surrounding asset management suggest that life cycle costs and management costs of engineered assets are recommended to be offset with the use of natural assets (Courtenay Council, 2019). The staff report on the asset management bylaw adaption process discussed that, where possible, alternative natural assets should be sought instead of engineered assets. The city also highlights that natural assets may go unmonitored as there are expected benefits regarding social recreation and overall self-sufficiency when using

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natural assets. This suggests that the city views natural assets are an opportunity for costly asset management practices. Given this, the city is rated for excellent performance for this indicator.

City of Oshawa

The City of Oshawa has an active asset management plan that was updated in 2021 (Oshawa Finance Committee, 2021). Within this asset management plan, the primary challenge is the availability of data. The city is lacking data regarding the condition of several municipal bridges, culverts, buildings, fleets and roads. Similarly, they lack datasets for their natural assets. The city does not have established data for levels of service for all their assets classes. Within the asset management plan, they have a total of five asset classes ranging from engrained assets to what they define as green or natural assets. The final data set that the city lacks is the value of its assets.

By contrast, the major opportunity for the city for natural asset management is their update to the asset management plan. Within Ontario, municipalities' reports on asset management are regulated through Ontario. O. Reg. 588/17. The regulation calls for all municipalities to implement an asset management plan by July 2023. This regulation is centered around grey infrastructure assets but there is emphasis on green infrastructure, defined by the regulation as existing natural systems or infrastructure consisting of human-made services that provide ecological and hydrological functions. This suggests that the city views natural assets as an opportunity within its overall asset management, and successful implementation for the city comes from its updated documentation (Oshawa Finance Committee, 2021). Given this, the city is rated as excellent for this indicator.

Region of Peel

The Region of Peel has an active asset management plan that was updated in 2021 (ROP, 2021a). There are three main barriers to the implementation of natural assets within the region: lack of data, limited asset mapping, and lack of ecosystem literacy and education amongst staff and governance (ROP, 2021a). The region managed several assets among the individual municipalities and, as a result, the region relies on the municipalities for asset management reporting. This lack of data also feeds into a lack of effective mapping of assets. Limitations in mapping impact the region's ability to monitor and visualize the assets across the region. Lastly, as a result of regional and municipal collaboration, there are different understandings of asset management and natural assets across staff. This creates organizational discrepancies, impacting the delivery of asset management practices. By contrast, the region identifies opportunities for implementing natural asset management as beneficial to the residents within the region. Within their Business Case of Natural Assets Report (CVC, 2020), the primary opportunity is viewing natural assets as beneficial to resident health and recreation. This suggests that the region views natural assets are an opportunity within their overall asset management practices. Given this, the city is rated as having excellent performance for this indicator.

5.2.2 Policy changes

Many municipalities have made changes to their existing policies, plans, and bylaws to integrate municipal natural asset management. The primary shift was seen within existing official plans and asset management plans. The focus on natural assets is often defined through green infrastructure or climate change planning. Many municipalities have also implemented climate change plans and new corporate implementation plans to highlight goals and benchmarks for natural asset management. Some municipalities have not carried out any policy changes. For

example, municipalities within New Brunswick have not made significant changes to their policy documents regarding natural asset management. It is important to note that the majority of municipalities are not utilizing language such as natural assets or natural asset management. The exceptions to this rule are Courtenay and Oshawa.

Town of Florenceville-Bristol

Florenceville-bristol has not updated or amended official documents since the completion of the NAI pilot project in 2020. The reporting has come from the pilot project, such as the technical and summary report at the last updated natural asset management initiatives. The town has noted in their communications that no work has been done to further the understanding and implementation of natural asset management since the pilot project. Given this, the municipality has a rating of poor performance.

Southeast Regional Service Commission

Within the Southeast Regional Service Commission, the lower-tier municipalities have made limited changes to their official documents. However, SERSC provides evidence within their annual reports that ecosystem services, such as natural assets, continue to play a large role in climate change planning for the region. This is further seen through the region-backed climate change plans in the rural region of Tantramar (SERSC, 2021b). Additionally, as of 2022, the region has a new land-use planning policy and regulation document known as Westmorland-Albert Rural Plan (SERSC, 2022). This plan provides provincially guided policies for natural resources, land conservation, and water quality. Although not directly related to natural asset management practices, these policies provide regulations that protect the existing natural assets within the region, including setbacks and development limits. Given this, the municipality has been rated as

having adequate performance, as the annual reports suggest a great shift in natural assets since 2018.

District of Sparwood

The District of Sparwood last updated their official plan in July of 2021, after the completion of the NAI pilot project, a new Asset Management Policy was adopted in 2022 (DSW, 2020). Although terminology such as natural assets cannot be found within the official plan, it has a whole section of goals associated with the environment. In particular, the municipality has specific policies, regulations, and enforcement for riparian areas around Elk Creek. Furthermore, the use of terminology such as sustainable infrastructure is used to discuss infrastructure solutions to protect the natural environment. However, no significant changes can be seen for zoning by-laws and secondary plans. Although changes to the official plan are not directly related to natural asset management, these policies provide regulations that protect the existing natural assets within the region. Given this, the municipality has a rating of adequate performance, as the annual reports suggest a shift of natural assets.

City of Courtenay

Courtenay adopted an asset management by-law in 2019 (City of Courtenay, 2019b) and a new official plan was adopted in 2022 (City of Courtney, 2022c). The asset management by-law defines two different types of assets, engineered and natural. The new official plan provides policy and implementation goals that put forward the implementation of the by-law. The official plan has a dedicated section on asset management. For natural assets within the city, they are defined through implementation goals, to protect and restore natural assets within municipal land, having three major purposes (City of Courtney, 202cb):

(1) Include natural capital (ecological assets) in the Asset Management Plan.

(2) Protect and restore environmentally sensitive areas and ecological assets on municipal properties.

(3) Achieve rain and stormwater management practices on municipal property that support both watershed health and public safety objectives, following the Integrated Rainwater Management Plan.

The official plan identifies existing natural assets and zones them according to these purposes. Natural assets within these zones are protected, providing services such as flood mitigation. The city does not have any notable secondary or community plans. Given that all relevant documentation has been updated, including the official plan and the zoning by-laws that consider the protection and development of natural assets, the municipality has been rated as having excellent performance.

City of Oshawa

The City of Oshawa has updated their official plan (City of Oshawa, 2022c) and their asset management plan (Oshawa Finance Committee, 2021). Additionally, the tree by-law has been updated as of 2021, as a result of the collaboration with LEAF. Aside from these documents, several secondary plans have not been updated. The asset management by-law defines two different types of assets, engineered and natural. From the changes made to these documents, the following can be understood:

(1) The entire section was revised to meet the requirements of the Natural Heritage System and ecological function protection from both the Greenbelt Plan and CLOCA watershed plans.

(2) New watershed targets added (e.g., 30% forest cover; 10% wetland cover; 75% riparian cover along streams).

(3) New requirements for environmental impact studies where development is in proximity to the Natural Heritage System.

(4) New policies restrict development within certain components of the Natural Heritage System and buffer areas.

(5) New policies require appropriate buffers for development proposals in proximity to a wooded area.

(6) The Asset Management Plan defines natural assets and green infrastructure.

The changes suggest that a major natural asset, the Natural Heritage System, has seen significant changes to its protection and enhancement. This could be a direct result of the asset management plan integrating language surrounding natural assets. Given that all relevant documentation has been updated, including the official plan and the zoning by-laws that consider the protection and development of natural assets, the municipality has been rated as having excellent performance.

Region of Peel

Since the completion of the NAI pilot project, Peel has updated their official plan (2022) and their asset management plan (2021). These plans dictate several other regional documents including the climate change master plan, zoning by-laws, and several secondary plans. They define the official plan and asset management plan to be the core guiding documents for asset management within the region. Within these documents, it is clear the region focuses on board policies to encourage municipal environmental initiatives. These plans encourage the lower tier to update their official documents for greater consideration of ecological services and natural systems (ROP, 2021a). For example, the official plan encourages the incorporation of natural systems into practices and existing infrastructure initiatives (ROP, 2022b). However, there is no

explicit change within these plans that utilizes language such as natural asset management, and the focus is on terminology such as green infrastructure, climate change, and biodiversity.

The changes to the documents suggest that the region places emphasis on protecting the natural environment but does not view natural asset management as a program or a practice. This responsibility is placed on the municipalities, as the municipalities manage assets outside of regional authorities. Despite relevant documentation that has been updated, including the official plan and the zoning by-laws that consider the protection and development of natural assets, the region places most of the NAM burden on lower-tier municipalities. Hence, it has been rated as having adequate performance for this indicator.

5.2.3 Project funding

Municipalities provide evidence that there are several new projects natural asset management projects, but it is often unclear how much funding these projects receive. In particular, it is unclear whether funding is specifically associated with natural assets and not overall asset management programs. This indicator focuses on whether they were appropriately budgeting for projects. For internal and external funding, municipalities are conservative when spending money on municipal natural asset management. Furthermore, financial reports suggest that asset management spending is not divided by the type of assets, making it difficult to confirm whether municipal natural assets are receiving financing. Overall, it is unclear how municipalities are budgeting their natural assets as a result of poor documentation.

Town of Florenceville-Bristol

No evidence could be found that since the pilot project took place in 2020, new natural asset projects have been funded. The municipality has noted in their communications that no work has

been done to further the understanding and implementation of NAM since the pilot project. Given this, the municipality is rated as having poor performance.

Southeast Regional Service Commission

Through a review of the annual report on the SERSC website, it is unclear what kinds of projects are receiving funding. However, conversations with the municipality suggest that much of the funding of land use projects and plans is internally reviewed, with only board fiscal budgeting released for each year. The region also expressed interest in future work with NAI, suggesting more natural asset management pilot projects may be ideal for the region at the moment. Given this understanding, the region has been rated as having poor performance.

District of Sparwood

A review of the District of Sparwood's Annual Financial Reports indicates that property taxes are the primary source of income for the district, with the majority of the budgeting being allocated to residential infrastructure, Class 1 with 26.6% of the yearly budgeting (DSW, 2023d). However, as of 2023, only 0.04% of the budget is allocated to Class 7 managed forests—this class is also associated with the carbon reserve fund and other environmental initiatives. The projected 5-year financial plan suggests that whereas overall income is expected to decrease 2023–2027, expenditure on environmentally related infinitives is expected to increase. Furthermore, the Municipal Annual Reports suggest that all major natural asset projects have received funding, this includes the Elk River Pedestrian Bridge Bank Stabilization Project at an estimated cost of $703,000 and the Centennial Square Project at an estimated cost of $485,000 (DSW, 2021b). Given that NAM projects and programs continue to receive funding from Sparwood, the municipality is rated as having excellent performance.

City of Courtenay

The City of Courtenay has seen a gradual increase in funding for assessment management projects. Since the adoption of the asset management by-laws, several asset management programs have seen an increase in funding. For example, water monitoring saw an increase of $100,000. Additionally, new targets were established for urban forest management, with a canopy cover target of 34–40% by 2050, and a tree reserve was created within the financial budgeting (City of Courtenay, 2020b). However, in 2021, the city published a statement of financial information (City of Courtenay, 2021b). This statement suggests that, in 2021, the city's general asset management reserve was allotted $869,859 in funding, whereas, in 2020, this number was $697,285. Similarly, the tree reserve was allotted $120,052 in 2021, an increase from 2020 to $94,690. Although it is unclear whether changes include natural assets, the city has allocated most costs to asset management since the implementation of the by-laws. The city has reorganized their financial budgeting to focus more on asset management. Given this, the region is rated excellent for this category.

City of Oshawa

A review of the City of Oshawa's financial statements and past projects suggests that while funding is available for asset management, it is unclear whether this funding is directed towards natural assets (City of Oshawa, 2021b). A review of the financial statement from 2019 to 2021, suggests that expenditure on asset management has increased yearly but does not detail the types of assets receiving funding. No evidence can be found on grant funding from external parties for natural asset projects. Given this, Oshawa is given a poor performance rating.

Region of Peel

Peel, similar to Oshawa, has no significant funding for natural asset projects (ROP, 2021b). A review of the financial statements from 2019 to 2022 suggests that expenditure on asset management has increased yearly but does not expand on the types of assets receiving funding. While the municipality does provide some information on their asset management spending, they fail to provide a context of the natural asset management spending. Given this, the region is rated as having poor performance.

5.2.4 New policies

The majority of municipalities have not created a specific policy for new natural asset management. The exception is Courtney which has implemented new natural asset management by-laws. Despite this, many municipalities are focused on updating existing policies to best align with their municipal natural asset management. Municipalities within New Brunswick did not update any of their plans. Regional authorities encourage their municipalities to change policies, for example, both Peel and the SERSC have updated regional documents to suggest that natural asset management is a responsibility of the municipalities.

Town of Florenceville-Bristol

Since the pilot project took place in 2020, no new natural asset policies have been created. The municipality has noted in their communications that no work has been done to further the understanding and implementation of NAM since the pilot project. Given this, the municipality has a poor performance rating.

Southeast Regional Service Commission

Within the Southeast Regional Service Commission or the lower-tier municipalities, no evidence can be found that new policies specific to natural asset management have been created.

However, policies related to the environment and climate change as a whole can be seen through the new Rural Planning Regulations (SERSC, 2022). Although not specific to natural asset management, the document utilizes language and terms that can support natural asset management projects in the future. Given this, the region is rated as having poor performance.

District of Sparwood

The District of Sparwood has established a natural asset management policy (DSW, 2020) The policy describes that the combined efforts of managing both engineered assets and natural assets will lead to sustainable practice within the municipality. Furthermore, the policy will be the guiding framework for all municipal reporting and monitoring of assets. This policy is relevant to all municipal documents including (DSW, 2020):

- Official Community Plan;

- Corporate Strategic Plan;

- Five-Year Financial Plan;

- Operational plans and budgets

- Annual Municipal Reports;

- Design criteria and specifications;

- Infrastructure servicing, management and replacement plans (e.g., transportation plan).

Where this policy is relevant to all asset management within Sparwood, the policy is not yet implemented. Despite this, the municipality is rated as having excellent performance.

City of Courtenay

Within Courtenay, several new policies have come into action since the completion of the NAI pilot program. To begin, the asset management by-laws encourage specific policy changes within

the Official Plan (2022). The Official Plan highlights the following policies for natural asset management (City of Courtenay, 2022c):

- Continue to integrate trees, forests, and green infrastructure into asset management planning, including budgeting, policy development, and staff resourcing.

- Utilize ecological services provided by natural systems wherever practical. This means applying and integrating natural capital in the city's Asset Management Plan to provide for its maintenance and regular support alongside traditional capital assets. This also includes reclamation and restoration of degraded natural assets.

These policies have put forth new strategic actions that can be seen through the city's asset management plan. The actions include:

- Protect and restore natural assets on municipal land.

- Include climate adaptation considerations in all municipal infrastructure.

Alongside these changes to policies, there are several other plans. A review of the annual reports from 2019 to 2021 suggests that the city is taking on a tree management plan and a flood management plan that will manage specific natural assets concerning the strategic goals set out by the council (City of Courtney, 2019a; 2023b). Given this, Courtenay has an excellent performance rating.

City of Oshawa

Within the City of Oshawa, there are no new policies directed towards natural asset management. Several new policies concerning the Natural Heritage System have come into action since the completion of the NAI pilot program. However, there is no specific policy concerning natural asset management as a practice or program. While the asset management plan does define

natural assets, it does not classify them as monitored or valuated assets. This implies that since the pilot project, no new NAM policies have been created. Given this, the municipality has been given a rating of poor performance.

Region of Peel

Peel has not established a specific policy concerning natural asset management as a practice or program. While the asset management plan does define green infrastructure assets, it does not classify them as monitored or valued natural assets. This implies that since the pilot project, no new natural asset management policies have been created. Given this, the region is rated as having poor performance.

5.3 Ecosystem rehabilitation and restoration outcomes

5.3.1 Ecosystem service quality metrics

This indicator had low scores across all municipalities. While most municipalities have identified metrics, such as water quality or species monitoring, that correlate to municipal natural asset health, they have not done so within an established natural asset inventory. Municipalities such as Florenceville-Bristol have done no work on advancing natural assets since their pilot natural asset projects with NAI. Other municipalities, such as Courtenay, have a greater understanding of municipal natural assets within their policy documents but still fail to produce metrics that monitor all of their natural assets. Furthermore, despite many municipalities updating their official documents to reflect natural asset management, many fail to address how these new policies, plans, and strategies will be measured or implemented. No municipalities have attempted to establish a comprehensive ecosystem service monitoring program or inventory.

Town of Florenceville-Bristol

Florenceville-Bristol successfully produced a natural asset inventory as part of their pilot project with NAI. This natural asset inventory is measured using metrics of land classifications and topology of woodland landscapes. It also measured tree populations and tree counts (NAI, 2020). However, the municipality has noted in their digital communications that no work has been done to further the understanding and implementation of natural asset inventory since the pilot project. While the original natural asset inventory is still active and publicly available, it has not been updated since the project's completion. There was no evidence that other metrics are being measured. Given this, the municipality has been rated as having poor performance.

Southeast Regional Service Commission

The Southeast Regional Service Commission is working with their low-tier municipalities to collect data for several ecosystem services. This ecosystem services data is often used during the creation and implementation of community-focused climate change plans. For example, the Climate Change Adaption Plan (2021b) utilizes several metrics such as flood mapping, local climate monitoring, and local air quality to generate modelling scenarios for climate change adaption best practices. Some of these models consist of climate, flooding, and heavy storm scenarios utilizing a variety of data to inform decision-making (Town of Riverview, 2021). Similarly, the Rural Tantramar Climate Change Plan (SERSC, 2021b) utilizes climate data, such as local historic temperature, precipitation, wind, and sea-level rise, to inform flood modelling and hazard risk assessment practices. However, the data collected by SERSC is not contributing to a natural asset inventory and the dataset produced is not publicly available. Furthermore, the region has limited data on ecological and social metrics that contribute to

ecosystem service valuation. Given this, SERSC is rated as having minimal progress for this indicator.

District of Sparwood

Sparwood has done considerable work to establish data metrics for several ecosystem services. The municipality states on its website that, as the community experiences climate change impacts, a goal is to provide residents with information regarding changes to the surrounding natural environment. The community references an established data inventory for the geographical basin the municipality resides within, known as the Columbia Basin Climate Source (Selkirk College. 2021). This inventory consists of 40 ecosystem and climate metrics. Climate metrics, such as temperature, precipitation, growing seasons, and extreme weather, are used to inform ecosystem service metrics for flooding, wildfire, and invasive species. Sparwood has not created this inventory but they utilize the data within this inventory to measure their metrics. Additionally, the municipality provides data to the inventory through the social data they collect from their climate change surveys. This data is used to inform metrics for quality of life within the basin and in Sparwood (CBT Community Profile, 2017). The Columbia Basin Climate Source provides generalized data and is not specific to the natural assets within Sparwood. Given this, the municipality is classified as having minimal progress for this indicator.

City of Courtenay

Courtenay has established data metrics for several ecosystem services. Environmental and ecosystem data is collected as a result of the Corporate Climate Action Plan and Policies (City of Courtney, 2009). This plan and policy suggest that climate metrics are actively collected, such as temperature, air quality, perception, and storm frequency, However, ecological

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and social metrics are only collected on a project basis. Furthermore, the city has an open data

inventory, publicly accessible on its website. Within this open data portal, several data files

pertain to ecosystem services (CourtneyOpenData, 2023). Data is presented through the

monitoring of river and stream topography, woodland land classification, and water quality.

While the town does collect and publicize several environmental datasets, the metadata for these

datasets indicates that the measure is often topological. There is a limited understanding of

natural asset performance and ecosystem health within these visual datasets. Given this,

Courtenay is rated as having poor progress for this indicator.

City of Oshawa

The City of Oshawa utilizes data from CLOCA, as the conservation authority has several

established ecosystem service metrics. CLOCA provides monitors ecosystem service metrics

such as water quality, air quality, flooding mitigation, aquatic species and habitats, and woodland

classifications (CLOCA, 2023). This data is utilized by both Oshawa and CLOCA to inform

decision-making for land use planning and ecological projection. Similar datasets can also be

found on Oshawa Open Data Porta. This public data inventory tracks and monitors several

natural assets, such as streams and woodlands, and these data are presented through GIS and

serve as basic visual information. Project-specific data collection is also conducted through

province-mandated environmental assets. This might include bank erosion, flood mitigation, and

habitats. The city lacks social data. Whereas data surrounding ecosystem services is collected

indirectly through project-based community consultation, this data is not represented within the

overall datasets. All monitored metrics can be found within generic data inventories. Given this,

Oshawa is given a poor progress rating.

Region of Peel

Peel is similar in performance to Oshawa. Peel utilizes data from the CVC and TRCA, as the conservation authorities have several established ecosystem service metrics. CVC and TRCA provide monitoring ecosystem service metrics such as water quality, air quality, flooding mitigation, aquatic species and habitats, and woodland classifications. Similar datasets can also be found on Peel Regions Open Data Portal (DataPeelRegion, 2023). This public data inventory tracks and monitors several natural assets such as streams and woodlands. This data portal also stores datasets collected and monitored by lower-tier municipalities within the region. Project-specific data collection is conducted through provincial-mandated environmental assets, but these environmental assessments are often conducted at a municipal level and report to the region. Whereas data surrounding ecosystem services may be collected indirectly through project-based community consultation, these data are not represented in the overall datasets. All monitored metrics can be found within generic data inventories, indicating the lack of a specific natural asset inventory. Given this, Peel is rated as having poor progress for this indicator.

5.3.2 Rehabilitation site selection

The majority of municipalities have at least one new project or site allocated for an ecosystem rehabilitation and restoration project. One exception to this is the municipalities within New Brunswick. The region authority of SERSC has established new projects outside of the case study municipalities concerning natural asset management through the new regional climate change plan. Another exception is the Region of Peel—they do not have projects associated with rehabilitation or restoration but their documentation highlights their support for municipal projects.

Town of Florenceville-Bristol

Florenceville-Bristol has no rehabilitation site selected after the completion of their NAI pilot projects. Similar to other indicators for FVB, no work has been done to further implement natural asset management. While the municipality has established other asset management projects, such as road repairs, no natural asset-related projects can be identified (FVB, 2017). Given this, the municipality is rated as having poor progress for this indicator.

Southeast Regional Service Commission

The Southeast Regional Service Commission has established project areas of interest through climate change action. Since 2021, the region's planning department, PLAN360, has been working to implement the Rural Tantramar Climate Change Adaptation Plan (SERSC, 2021b). Although not directly a rehabilitation or restoration project, this plan provides a spatial understanding of sensitive areas. This defines boundaries around areas of restoration and rehabilitation, specifically involving infrastructure damage of climate change impacts. Given this, the region has been rated as having adequate progress for this indicator.

District of Sparwood

The District of Sparwood has done considerable project-based work since the competition of their NAI pilot project. The municipality has identified 3 new sites for a natural asset project: Elk River Pedestrian Bridge Bank Stabilization, Centennial Square, and the Red Cedar Drive Rehabilitation project. The first project, Elk River Pedestrian Bridge Bank Stabilization, focuses on bank erosion around a municipal bridge (DSW, 2022b). This project combines the restoration of an engineered asset with a natural asset, the banks of Elk River. This project has received grant funding and has been approved. The Centennial Square Project is a social natural asset project, focusing on reimagining Centennial Square into a recreational green

space. This project places a naturalized landscape on existing engineered assets to provide

benefits such as tree cover shade (DSW, 2023c). This project has received funding through

municipal budgeting. Red Cedar Drive works toward stabilization and structural flood mitigation

to the Elk River Pedestrian Bridge to protect engineered infrastructure (DWS, 2022)—funding is

pending.

Given that the municipality continues to focus on the areas around the Elk River, an area

of focus in their NAI pilot, they have exceeded the benchmark established. Although these projects

are not directly acknowledged as NAM, their association with the NAI project locations suggests

that the importance of Elk River continues to be a priority. Hence, Sparwood has an excellent

performance rating.

City of Courtenay

Courtenay has identified several project areas of interest for rehabilitation. In terms of

natural asset management, the city has identified 4 ongoing projects. The first is McPhee

Meadows, a donated property that is to be utilized as a natural green space. City staff have been

working with consultants to develop a conceptual design to inform the opening of a 4.6-hectare

(11-acre) green space along the Puntledge River to the public while preserving and restoring its

riparian and wildlife habitat features (City of Courtenay, 2022b). The project was put forward in

2021 and construction is expected to end in the summer of 2024. The next project is the 6th Street

Bridge project. This project began in 2020, with the purpose to provide a pedestrian bridge and

restore the trail network around the Courtenay River. This project is expected to expand the

existing train network and encourage social awareness of natural assets (City of Courtenay,

2020c). The other two projects are municipal management plans, the Flood Management Plan

(2023) and the Integrated Rainwater Management Plan (2019). Both of these plans will improve

the overall natural watercourse system within the city. These plans define their purpose through climate change-related flood mitigation and the improvement of water quality through the management of aquifers (City of Courtenay, 2023b). The outcome of these projects will result in the protection and sustainable use of the Courtenay River. Through document review, it is clear that the town has a significant focus on natural asset projects, identifying the social, economic, and physical benefits that natural assets bring to their community. Given this, the city has an excellent performance rating.

City of Oshawa

Oshawa has identified several projects for rehabilitation. In terms of natural asset management, the city has identified 3 ongoing projects as of late 2022. These projects are primarily focused on shorelines and watercourses, emphasizing the city's concerns for stormwater management and erosion. The Creek Bank Erosion project (City of Oshawa, 2022f) focuses on the restoration of several banks along the Oshawa creek as well as watercourses. The focus is primarily on the protection of the creek banks, as they prove as a barrier between excess water and development in the chance of flooding. The next, done in collaboration with HAPPA, is the Oshawa Harbour Project (City of Oshawa, 2022g). This project, although not directly focused on natural assets, identifies the recreation value of the lakeshore. The project aims to restore the old harbour and focus on improving the water quality around the harbour. The last project is the restoration of Oshawa Creek. In this project, there are several areas of focus including residential land control, shoreline connectivity, and native species gardens (City of Oshawa, 2021a). This is to protect the creek and its ecosystems, in turn benefiting all watercourses in the city. Given this, the city is rated as having excellent performance for this indicator.

Region of Peel

Peel has several ongoing projects concerning the regional watershed, as stated on their region's website. Environmental projects within the watershed are the responsibility of the conservation authority. The region has identified a stormwater management project for regional roads that has a completed environmental assessment as of 2022 (ROP, 2022f. However, despite these efforts, many of the asset management projects are taken on by the individual municipalities and the region only provides support and comments where necessary. The asset management projects currently active within the region are not directly related to natural assets but rather focus on improving engineering assets to reduce the impacts of stormwater runoff. Through the document review, it is clear that the town has a significant focus on asset management projects but fails to define any sites for natural asset restoration or rehabilitation. Given this, the region has been noted for a minimal performance rating.

5.3.3 Monitoring Indicators

The majority of municipalities have identified at least one indicator concerning municipal natural asset management. These indicators often concern existing natural assets. Many municipalities monitor these indicators through open data provided within geographic information system portals. Mapping of watersheds, woodlands, and flooding are common ways that municipalities manage their protected ecosystem areas. Furthermore, several indicators in policies or plans are not publicly displayed. It is important to note that many of these municipal documents do not specify natural asset management, and the indicators are related to ecosystem services.

Town of Florenceville-Bristol

Florenceville-Bristol has not identified any indicators for the lifecycle of natural asset management projects. The Strategic Plan (2017–2020), highlights one of the goals of FVB, to be

completed by 2020, was to implement an asset management plan. This plan was not created or implemented. As a result, FVB has not identified indicators that monitor their asset management or natural asset management projects. Given that no information could be found, the town rating is inconclusive for this indicator.

Southeast Regional Service Commission

The Southeast Regional Service Commission has established several flooding hydrology indicators to monitor natural asset management practices. The 2021 Annual Report states sea-level rise and flood risk are indicators used for the region's progress in implementing its climate change action plans (SERSC, 2021a). These indicators are monitored through inland flood hazard mapping. This mapping is then used to identify the areas impacted by 100-year floods. As of 2021, they began integrating freshwater and seawater mapping into their regional flooding models. Whereas the indicators may not be directly related to natural asset management, they assist with the implementation of climate change plans that are the facilitators. Given this, the region is rated as having good performance for this indicator.

District of Sparwood

Sparwood has identified several natural asset management indicators that are split into two areas, environment and infrastructure. Sparwood defines these indicators within their 2019-2022 Strategic Priorities Report. The phrase success indicators are used to define measurable outcomes that can be assessed through the quantification of tangible outputs. The most relevant environmental indicators for natural asset management are (1) urban forest management, (2) air quality, (3) water, and (4) riparian protection (DSW, 2019). The most relevant infrastructure indicators for natural asset management are (1) sustainable infrastructure funding and (2) asset management/lifecycle planning. These indicators are used to monitor the overall land-use

planning initiatives within the municipality. In particular, they guide the decision-making of the council when considering the implementation of policy documents such as the Official Plan, the corporate strategic plan, Five Year Financial Plan, and the Asset Management by-law (DSW, 2019). While not all these indicators are specific to natural asset management, they will be natural asset management initiatives within the municipality. Given this, Sparwood has an excellent performance score.

City of Courtenay

Courtenay has emphasized monitoring the outcomes of natural asset projects. As a result, the implementation plan for their Community Official Plan (City of Courtenay, 2022c) has defined performance indicators. The performance indicators, similar to Sparwood, are methods to quantify outcomes as initiatives progress. The official plan states, in terms of environmental and asset management, new indicators are still being developed. One of the existing indicators is flood risk within the city. This need for advancing the knowledge and understanding surrounding natural assets has resulted in the use of GIS to produce maps that can outline areas of concern. However, the city has not effectively reported on the progress of defining these new indicators. Despite the lack of reporting, the city has defined at least one indicator that measures the performance of natural asset management. Given this, the city has an excellent performance rating.

City of Oshawa

Oshawa, with guidance from the Durham region, has established several indicators for natural asset management projects (City of Oshawa, 2021bh). The city is successfully tracking metrics such as water quality, invasive species, trees, pests, and flood risk, with all data sets separately organized and outside of a natural asset inventory (OshawaOpenData, 2023). The

municipality also has indicators of canopy cover as a result of their tree by-law (City of Oshawa, 2022i). Many of the updated documents within the city and the region call for implementation and monitoring strategies for the work being done. However, whereas the city does report on the progress of its projects, monitoring efforts are not made public. Furthermore, these indicators are not specific to natural asset management. Given this, the city is rated as having good performance for this indicator.

Region of Peel

Peel has established indicators within their existing efforts for climate change mitigation and adaption that can be utilized for natural asset management projects. The primary indicator is flood risk. The monitoring of flooding volume and frequency is utilized as an indicator of watershed health and stressors (OpenDataPeelRegion, 2023). The indicator is noted publicly, providing GIS maps of floodplains and watercourses in the watershed. However, despite the efforts to monitor flooding, this is not identified as an indicator of natural asset management and has not been updated or added to a natural asset inventory. Given this, the region is given a good performance rating for this indicator. The region is encouraged to publicize all indicators that may be used for the measurement of their project progress and implementation.

5.4 Service delivery outcomes

5.4.1 Percentage increase of co-benefits

The majority of municipalities have limited data that suggest that there has been an increase in co-benefits concerning service delivery outcomes. The scores are either low or inconclusive. It is important to note that the NAI pilot projects were implemented from 2018 to 2021, providing a short time window to quantify co-benefits within these municipalities. Furthermore, many

municipalities acknowledge generic co-benefits but have not identified specific ones. Overall, municipalities cannot at the moment report an increase in co-benefits.

Town of Florenceville-Bristol

Florenceville-Bristol has no documented evidence that suggests that FVB monitors the increase in co-benefits. Digital communications in the form of emails with the town further highlight that no work has been done since the NAI pilot project. Whereas the pilot project highlights the importance of natural assets in the town, no work has been done to further the findings from the pilot or update the natural asset inventory. This results in an inconclusive score.

Southeast Regional Service Commission

Although no co-benefits have been reported since the implementation of the pilot projects, the region has identified on their PLAN360 website that they understand and acknowledge the benefits of their current infrastructure and operations. This implies that SERSC is aware of the benefits that their current natural assets have on factors such as flood mitigation, soil health, shoreline recreation and several other region-specific benefits. However, these are only coarsely understood (SERSC, 2023). These benefits are not studied or monitored to provide produce geographically accurate co-benefits specific to SERSC. Hence, the region has a minimal performance score, as its benefits are not specific to its natural assets.

District of Sparwood

Sparwood has not reported on co-benefits experienced as a result of natural asset management. In their documentation, such as their Community Official Plan and their Community Sustainability Plan, Sparwood has identified the benefits that they may be experiencing from

their current natural infrastructure (DSW, 2009, 2021a). These benefits are generally understood, such as ecosystem health and diversity, flood mitigation, and water quality. This implies that the municipality is aware of the benefits that its current natural assets may have on its municipal infrastructure and community. Hence, the region has a minimal performance rating, as more work can be done to specify their natural assets.

City of Courtenay

Courtenay states within its official plan that the city understands that natural assets bring benefits. These benefits are broadly understood by the city as reduced flooding costs, improved community safety and social recreation, and the overall improvement of ecosystem health (City of Courtney, 2022c). The official indicates that the city is allowing nature to 'do the work', but the city is not monitoring the outcomes of natural asset management (City of Courtney, 2022c). The region has a minimal performance rating, as only generic or expected benefits are being defined in municipal documentation.

City of Oshawa

Oshawa has done minimal work to quantify the co-benefits experience from their natural asset management practices. The Official Plan and the Asset Management Plan suggest that the city does understand the ecosystem services that come with existing natural assets (Oshawa Finance Committee, 2021; City of Oshawa, 2022c). This is primarily seen with the establishment of the Natural Heritage System. As noted by the council, the municipality is to enhance the system to combat climate change impacts at a broad scale. However, the city does not report on monitoring within the system, as this is primarily done through the conservation authorities. The benefits of the natural heritage system are acknowledged for climate change and environmental

health, but they are not monitored or valued through natural asset management. The city has a poor performance rating, as the benefits of natural asset management are not understood or recorded.

Region of Peel

No documented evidence could be found that suggests that Peel monitors co-benefits. Whereas the pilot project highlights the importance of natural assets within the region, no work has been done to further the findings from the pilot or update the natural asset inventory (Region of Peel, 2022e). This resulted in an inconclusive score.

5.4.2 Municipal budget for grey infrastructure renewal

This indicator primarily has low scores across study areas. While many municipalities are making efforts to value their natural assets, budgeting is still largely based on grey infrastructure renewal and shows limited evidence of impacts as a result of natural asset management. Many municipalities expected an increase in funding as a result of the growing population and development.

Town of Florenceville-Bristol

Limited information can be found on annual budgeting for asset management and natural asset management. Digital communications in the form of emails with the town further highlight that no work has been done since the NAI pilot project. FVB has not made an effort to further apply the NAI pilot project to new natural asset projects. This resulted in an inconclusive score.

Southeast Regional Service Commission

For the Southeast Regional Service Commission, the Annual Reports (2019–2021) indicate that expenditure on engineered assets has annual increased every year (SERSC, 2021a). This can be a result of the growing population within the region. There is no reporting or understanding of the monetary benefits of natural assets and the expected reduction of costs. Hence, the municipality has a poor performance score.

District of Sparwood

For Sparwood, the annual financial reports (2020-2023) indicate that expenditure on engineered assets is expected to increase within a project 5-year period. This is a result of the growing population of Sparwood (DSW, 2023d). Additionally, there is no reporting of the monetary benefits of natural assets and the expected reduction of costs. The majority of work done for natural asset management is funded through grants, but the monetary value of these projects is not reflected in financial planning. Hence, the municipality has a poor performance rating.

City of Courtenay

A review of Courtenay's financial statement for the years 2019-2021 suggests that no evidence can be found that natural assets have decreased spending on asset management for grey infrastructure. In 2021, the city published financial information which indicates that in 2021 the city's general asset management reserve was allotted $869,859 in funding; in 2020, this number was $697,285 (City of Courtenay, 2021b). The tree reserve was allotted $120,052 in 2021, an increase from 2020 to $94,690. Although it is unclear whether changes include natural assets, the city has allocated an increasing percentage of their budget to managing engineered assets, despite the implementation of a natural asset management by-law and the Asset Management Plan. This

increase in cost is the result of the growing population and development within the city. However, the city is not reporting costs that are minimized as a result of natural asset management. Given this, the City has a rating of poor performance.

City of Oshawa

A review of Oshawa's financial statements from 2019-2021 indicates no evidence that natural assets have decreased spending on asset management concerning engineered assets. The financial statements from 2019-2021 suggest that the city's expenditure for asset management has increased yearly on average by $1 million (City of Oshawa, 2021a). However, these expenses can be a result of increasing in the amount of assets supported as the municipality grows. It can be assumed that natural assets are not being monitored fiscally, resulting in a lack of value subtracted from the annual increases in spending. Given this, the city has a poor performance rating.

Region of Peel

A Review of Peel Regions Infrastructure Status and Outlook Report from 2019-2022 indicates that expenditure on asset management has seen a $10 billion increase within the last 4 years (ROP, 2022e). These reports break down all the asset management, including wastewater, roads, bridges, buildings, pipes and social housing support (ROP, 2022e). Natural assets are not monitored or reported. It can be assumed that the increase in asset management expenses is a result of increasing development within the region. But natural assets are not being monitored fiscally, resulting in a lack of value subtracted from the annual increases in spending. Given this, the region has a poor performance rating.

Chapter 6: Discussion and Conclusions

6.0 Introduction

This chapter presents the general findings, followed by a discussion of results from Phase 1 and Phase 2 of the research. It presents key enablers and challenges that the case study municipalities experienced in natural asset management implementation. This chapter ends with recommendations for improving the methodology of natural asset management evaluation.

This chapter feeds into the growing knowledge of monitoring and evaluation of ecosystem-based services and NBS. Monitoring and evaluation of ecosystem-based services has evolved from the measurement of biophysical attributes to the evaluation of planning policy and programs surrounding their implementation. NBS evaluation is a prime example of the evaluation of land-use practices and planning policy, as NBS are often implemented for their greater co-benefits, resulting in the evaluation of the social, economic, finance, governance, and regulatory factors (Raymond et al, 2017). This has resulted in the creation of exemplary NBS evaluation frameworks that are applied globally by municipalities, following a common theme of seven cyclical stages: 1) identify problem or opportunity; 2) select NBS and related actions; 3) design NBS implementation processes; 4) implement NBS; 5) frequently engage stakeholders and communicate co-benefits; 6) transfer and upscale NBS, and 7) monitor and evaluate co-benefits (Raymond et al., 2017). As a result of this framework, municipalities are often able to produce stronger evidence on NBS benefits and are able to adapt to challenges that may arise within policy, governance, and financing of environmental initiatives (Kabisch et al., 2016; Frantzeskaki, 2019). Similar to this earlier work, the following discussion notes the effectiveness and limitations of the NAM evaluation framework presented through the analysis of several key

enablers and challenges of NAM implementation, which contributes to the existing literature on NBS evaluation and frameworks.

6.1 General findings

The results suggest that the municipalities evaluated primarily have high scores for awareness, capacity and education indicators and some implementation indicators. The majority of the evaluated municipalities are making the public aware of municipal natural asset management, but this is primarily through informational material and not through consultation. Furthermore, municipalities excel at establishing partnerships and identifying barriers and opportunities for municipal natural asset management. By contrast, municipalities received low scores for ecosystem rehabilitation and restoration indicators and service delivery indicators. While many municipalities have established natural asset management projects, they are failing to create ecosystem service quality measurements or metrics. No municipality could provide evidence of a natural asset management inventory (except for the Town of Florencevile-Bristol which created an inventory during their NAI pilot project but has failed to update this inventory since the completion of the project). Similarly, whereas municipalities may be able to define the potential benefits of utilizing natural asset management, they failed to provide evidence for increased co-benefits. Some municipalities, such as SERSC, have been able to provide a generic understanding of natural asset management impacts but are too early in the life cycle of their projects to produce evidence of robust co-benefits. This lack of evidence also leads to a limited understanding of reduced spending on infrastructure restoration.

Similarity among the municipalities includes the use of natural asset management for climate change initiatives. For example, municipalities, such as the City of Courtenay, have created natural asset management by-laws and made changes to existing policies, projects and

programs to accommodate natural asset management. They have done so through existing measures of climate change mitigation and adaption. While these climate change initiatives are effective in addressing ecosystem service decline, natural asset management should also be intertwined with existing asset management practices (Deetjen et al., 2018; Burch et al., 2014). The grouping of environmental initiatives is often a result of poor climate or ecosystem literacy within municipal planning departments (Coningsby & Behan 2019). Municipalities also show signs of limited regional understanding of ecosystem services. This can result in generic or ineffective policies to address nature-based solutions, such as natural asset management, even with existing climate change knowledge (Burch, 2010).

Several municipalities attempted to make changes to existing policies but performed poorly due to a lack of knowledge of effective natural asset management implementation. Sparwood and Courtenay made new policies to address their natural asset management. Sparwood in an interesting case where even with a robust new natural asset management policy, it was not effectively integrated into the existing planning documentation, thus proving ineffective. By contrast, Courtenay was able to effectively change existing policies and implement new policies. This suggests municipalities may be ineffectively addressing natural asset management when there is a gap between planning policy and plans.

Another notable similarity between the municipalities is the limited consultation events for natural asset management. The municipalities did not carry out or measure attendance for natural asset management consultation events. Whereas natural asset management is discussed as a result of other key programs or initiatives, no municipality has carried out consultation for natural asset management specifically. Municipalities can provide evidence of educational material for the public concerning natural asset management but, with limited data surrounding

past consultation events, it is difficult to gauge public interest. As a result, all municipalities had

an inconclusive score for this indicator. In general, most municipalities have low attendance rates

for engagement events despite high resource inputs (Coningsby & Behan 2019).

6.2 Comparison between Phase 1 and Phase 2

Cohort 1 consisted of five municipalities, the Town of Gibson's, the City of Grand Forks,

the City of Nanaimo, the District of West Vancouver, and the Town of Oakville. The findings

suggested that municipalities were progressing well in awareness, capacity, and education

outcomes, as well as some implementation outcomes. By contrast, the municipalities had limited

progress in ecosystem rehabilitation and restoration outcomes as well as service delivery

outcomes. The evaluations suggest that the possible reasons are the slow uptake of municipal

natural asset management approaches from managerial staff (Mollame & Drescher, 2021). With

no new or limited natural asset management programs or policies in the evaluated municipalities,

paired with a lack of monitoring metrics, natural asset management was not progressing.

Cohort 2 municipalities were evaluated with 3 different provincial guidelines, resulting in

different levels of progression. The case studies in British Columbia are progressing well with

their implementation outcomes in comparison to case studies in New Brunswick and Ontario.

Despite the same population and institution size of BC municipalities, they have all implemented

a natural asset management policy or plan as an outcome of their NAI pilot project. This may be

a direct result of the existing BC Asset Management Framework placing greater emphasis on

natural assets. The case studies in Ontario are progressing well in terms of awareness and

education outcomes. However, they are progressing slowly in terms of changes in policy and

plans, even though many were updated after the completion of the pilot projects. Considering

that Ontario municipalities are required to complete an asset management plan by July 2023 in

compliance with Ontario regulations, there is potential that this update will provide a greater focus on natural assets through the lens of green infrastructure. The New Brunswick municipalities have seen the least progress. This could be the result of several provincial changes to their planning environment, including the amalgamation of several municipalities as of January 2023. The overall results suggest that most municipalities are progressing well within awareness and education outcomes, and some are implementing new natural asset projects. But others are failing to update their policies and plans.

Results from Phases 1 and 2 suggest that more monitoring is needed throughout the life cycle of natural asset management programs and projects. While work is being done, many municipalities face challenges such as organizational staffing changes, lack of funding, and lack of provincial guidance. This directly impacts the municipalities' ability to monitor the progress and outcomes of their natural asset management programs. The review of all municipalities suggests that there is a need for continuous monitoring to understand the impacts and changes as a result of their natural asset work.

6.3 Enablers and challenges of implementing natural asset management

The evaluation of Phases 1 and 2 shows similar results in various areas of the evaluation framework. These similarities are a result of various possible challenges and enablers of natural asset management for municipal implementation. There are several common themes seen throughout the evaluation that can be presented as challenges: lack of knowledge and understanding of natural asset management, lack of guidance for natural asset management, and lack of municipal resources. Despite these challenges, some enablers push municipalities to pursue or maintain natural asset management within their service delivery. These enablers can be categorized based on the following themes: utilizing existing policy, planning for climate change

adaption, and financial valuation of natural asset management. The following subsections present the breakdown of these themes as noted by the evaluated municipalities.

6.3.1 Challenges of implementation

Lack of knowledge and understanding of NAM

The municipalities evaluated had access to a natural asset management pilot project, providing information on natural asset management. Despite this, many municipalities have not been able to define the natural asset management practices that best suit their needs. This can be seen through the lack of evaluation metrics and natural asset inventories, as well as the lack of reporting on co-benefits. Municipalities that seek to implement natural asset management projects outside the scope of NAI may face significant challenges in defining these natural asset management practices, policies, and plans that cater to their regional needs. This is not only prevalent for natural asset management but also for ecosystem-based services as a whole (Robinson & Gore, 2005). This lack of understanding can result in ineffective policies and plans, especially when focusing on the valuation of ecosystem services (Frick et al., 2004; Orderud, 2012).

Lack of guidance on NAM work

Currently, there is no provincial policy for natural asset management across Canada. Asset Management BC is the first to present a framework for natural asset management, as a subset of existing asset management maintenance and reporting in British Columbia (Asset Management BC, 2015; 2019). Similarly, the Canadian Standards Association, has established a guideline for natural asset inventories (CSA, 2023). However, this does not make natural asset management a requirement across the province. Furthermore, this framework provides a limited understanding of

long-term monitoring and evaluation of natural asset management projects. Another example of limited guidance is seen in Ontario. O. Reg. 588/17 requires Ontario municipalities to implement asset management plans. These municipalities have the option to report on green infrastructure assets but are not required to do so. Natural assets management can be used to maintain green infrastructure assets, but often the difference occurs in the purpose of the defined natural assets (NAI, 2017). Depending on the perspective that municipalities have on natural assets, Green infrastructure assets can still be engineered, unlike existing natural spaces. As a result, natural assets may not be effectively prioritized with such a board policy. No significant policy could be found for the other case study provinces. This suggests that municipalities may want to implement natural asset management, but they risk not meeting existing asset management requirements set out in provincial documentation that does not define ecosystem services and natural infrastructure. Asset management planning, within the Canadian context, is reliant on provincial guidance and thresholds. The lack of provincial guidance becomes a barrier for municipalities looking to implement natural asset management projects, particularly impacting their ability to effectively report and evaluate what are considered valued assets (Halfawy, 2009; Burch, 2010).

Unstable municipal resources and governance

The most significant challenge that municipalities face in implementing natural asset management is limited resources in staff and budgeting. Within the evaluated municipalities, this challenge appears especially in the New Brunswick case studies. These municipalities have expressed that a lack of staff and funding limits their ability to advance natural asset implementation. With limited staff or with staff turnover, there is minimal capacity to take on projects that require implementation across municipal sectors to be effective. Limited budgeting impacts the municipalities' ability to define new restoration and rehabilitation projects that

expand on the existing natural asset management practices. A municipality with limited resources will prioritize existing services over integrating new services (Seasons, 2003).

This challenge of municipal resources also presents itself through changes in municipal governance, shifts in policy, and changes in politicians. The municipal application of natural asset management requires support from municipal governance. Changes to municipal governance also bring forth changes in priorities (Zakhour & Metzger, 2018). In Canada, elected councillors decide the primary concerns of the municipalities. A council that supports natural asset management may be replaced with a newly elected council that does not view it as a priority. Municipalities may also face governance challenges at the provincial level. For example, Florenceville-Bristol was reorganized by the provincial government and amalgamated with two other municipalities. This change limits their ability to carry out existing projects and may result in a loss of experienced staff. Changes in governance may lead to significant instability for municipalities, creating a barrier to the implementation of natural asset management as the life cycle requires long-term planning and evaluation (Measham et al., 2011).

6.3.2 Enablers of NAM implementation

Innovation of policy and programs

The evaluated municipalities have tried to change or implement new policies to integrate natural asset management into service delivery. Municipalities, such as Sparwood and Courtenay, are utilizing their existing asset management policies to expand on their natural asset management efforts. As many of the evaluated municipalities are provincially required to report on their asset management, the use of existing provincial policy and a focus on municipal innovative infrastructure has resulted in a growing interest in natural asset management (Measham et al., 2011).

Furthermore, municipalities with existing asset management plans utilize partnerships to carry out their policy changes. As noted by the evaluation, most municipalities had several partnerships that are focused on their municipal priority. The municipalities that partnered with NAI had a previous history of natural asset management. This indicates that municipalities may not have strict provincial guidance, but they are utilizing existing policies to innovate their asset management practices while exploring partnerships that may aid them in understanding natural asset management implementation and evaluation (Measham et al., 2011). Municipalities explore policy changes that best suit their needs, expand their understanding of natural asset management implementation, and then serve as an example for others (Measham et al., 2011).

Planning for climate change adaptation

Another key enabler for natural asset management is the municipal push for climate change adaptation. The focus on climate change can be seen across all governance tiers in Canada. Guided by the federal and provincial push to focus on resiliency and sustainability, many municipalities are exploring ways to implement climate change initiatives into their service delivery. For the evaluated municipalities, natural asset management serves as a project within existing climate change initiatives. Although this may not always be an effective approach to implementing natural asset management, it is often the foundation of interest in natural asset management practices (Guyadeen et al., 2019). Organizations such as the Federation of Canadian Municipalities encourage municipalities through support programs, partnerships and funding for climate change action (FCM, 2017). The FCM also recognizes climate change as a risk to municipal assets, providing risk management frameworks for municipalities to evaluate their existing assets. This growing interest in climate action is a key enabler that guides municipalities

in the direction of natural asset management and subsequent environmental initiatives (FCM, 2023).

Financial valuation of asset management

Assigning value to environment assets has grown significantly over the last few decades. As mentioned in the literature review, research has alluded to several methods and frameworks to establish economic value. This is commonly seen, in the Canadian context, at the provincial or regional level. At the municipal level, only engineered assets tend to be valued. Guerry et al. (2015) state that there is a lack of clarity regarding the valuation of natural spaces for municipal decision-makers or the public. However, with the growing capital debts involved with engineered assets, many municipalities have begun incorporating their natural assets through capital accounting in their annual budget (Bulte et al., 2008; Treger, 2019). For example, Oshawa and Peel provide detailed reports on their annual budgeting, often including funding and benchmarks for green initiatives such as urban forestry or clean water monitoring. These frameworks support valuing other natural assets, enabling municipalities to include these resources in their annual budgeting.

6.4 Addressing research gaps

This research contributes to knowledge surrounding the successful implementation of nature-based solutions, specifically the evaluation of implementation practices. This was through the creation and use of a monitoring and evaluation framework, designed specifically for municipal natural asset management programs. Phase 1 consisted of designing the monitoring and evaluation framework. This framework was further refined for efficiency in Phase 2. The outcome of these methodologies provides a standardized evaluation framework that can be used to create a reliable evidence database. This core framework, created through a program logic model, was applied to eleven municipal natural asset management programs in Cohorts 1 and 2.

The research indicates that few municipalities have created concrete natural asset management policies to further their implementation. For Phase 2, the only municipalities that had created these policies were Courtenay and Sparwood. This research highlights that the gap between defining a natural asset management project versus the program implementation is one of limited data, e.g., for restoration and rehabilitation of natural assets. Without municipal-specific ecosystem service quality metrics, municipalities cannot produce effective policies and plans for natural asset management implementation. As a result, municipalities continue to view natural asset management as a subset of existing programs with a limited understanding of the co-benefits produced by natural asset management efforts. This dissertation research helps close the gap in effective data usage for municipal policy planning.

6.5 Limitations of the evaluation

This research reveals that municipalities require monitoring to demonstrate the impacts of natural asset management programs. Hence, the first limitation of the data collection and analysis methodology is the extensive time required for such work. Phase 1 analyzed five municipalities and averaged around 30 documents and websites reviewed per municipality. This process can take months, especially when done by just one researcher. The interviews done in Phase 1 took additional time, as scheduling and completing the interviews can take months for both the research and the municipalities. Phase 1 took almost two years to complete.

The time required for Phase 2 was similar, as initially the same methodology was used. However, interviews posed a greater challenge. Many municipalities across the country underwent various organizational and legal changes, such as adapting to new provincial legislation or following municipal elections. Staffers were busy, leading to limited responses to interview requests. Accordingly, the methodology was adjusted, so that documents were

reviewed before interviews. Municipalities were then informed of the documents reviewed and asked to fill in any gaps, if needed, with interviews. However, interviews conducted post-document review resulted in increased time requirements—Phase 2 took approximately two years to complete.

The greatest limitation is that although the evaluation framework can be standardized, the amount of work done cannot be effectively replicated by the municipalities themselves. Municipalities standardizing the evaluation practices raise concerns for the consistency in rigour and interpretation of the evaluation matrix. Furthermore, many municipalities are struggling to implement their natural asset management programs and, as a result, have limited resources for lifecycle monitoring even when presented with a standardized framework. Hence, application of the current evaluation framework is useful, but it may be too much of a burden for municipalities. By contrast, evaluation done by an external party, such as NAI, may be able to decrease the municipal burden and contribute to increased rigour. However, given the growing number of municipalities adopting a municipal natural asset management approach, NAI may not be able to provide direct assistance to every participating municipality.

6.6 Implications for planning practice, education, and research.

Evaluations of planning practices are essential to improving the design and implementation of plans, policies, and programs (Seasons, 2021, pg. 181). This thesis research revealed a limited understanding of ecosystem services and their local value. With the evaluation, this research has built on current work on the importance of monitoring and evaluation and provides a specific evaluation framework that evaluates natural assets within Canadian municipalities (Seasons, 2021). The data were used to produce a standardized evaluation framework that increases the understanding of how indicators can be established for

environmental programs. In practice, the utilization of innovation in municipal policy can first be address through the creation of NAM databases. Exemplified by this research, many of the evaluated programs, plans and policies were not specifically related to NAM. This suggests that municipalities are making progress within NAM initiatives but are unaware of the existing data sources. Application of this evaluation framework should first begin with the creation of a NAM inventory or dataset of the existing efforts within the municipality. This will aid in the understanding of NAM practices across organizational departments and allow municipalities to determine the resources required to further the progress of NAM. Furthermore, municipalities can utilize the existing work towards their municipal climate change initiatives to educate and train staff on NAM practices, promoting a shift in language within other municipal programs, policies and plans. The use of climate change adaption as an enabler of NAM initiatives within municipalities is to be noted a starting point but as seen through case studies such as Sparwood and Courtenay, progressing NAM further through a review of official polices and plans places emphasis on municipal understanding and knowledge of NAM. Effective change in language and understanding of NAM within municipalities can being with the understanding how their work with other NBS is different in then NAM, moving towards a asset management perspective.

The methodology presents a revised evaluation framework for municipal natural asset management (Mollame & Drescher, 2021). This framework was used to produce outcomes for two different phases. This implies that the methodology can be applied by external evaluators when appropriately trained (Seasons, 2021, pg. 182). The evaluation methodology used can also be effectively used by professional planning institutes, such as the Canadian Institute of Planners or the Ontario Professional Planners Institute. Furthermore, natural asset management evaluation increases the emphasis on monitoring frameworks for climate change-focused initiatives,

furthering municipal interests in incorporating project outcomes in municipal delivery and reporting (Donatti et al., 2020; Guyadeen et al., 2019).

Lastly, this research contributes to the existing literature on climate change resilience, providing evidence for the effective use and management of natural asset management. This research is significant to national and regional climate change adaptation efforts, as it focuses on improving nature-based solution implementation. Natural asset management is currently an emerging field of study, with little literature understanding of how to provide value to existing natural spaces and advocate for the protection and restoration of more natural asset infrastructure. This research provides an avenue to assess the current work that is being done by municipalities and make this information available to academics through the use of case studies (Brooke et al., 2017; Milligan & Drescher, 2019).

6.7 Next steps for Natural Asset Management evaluation

There are further opportunities for natural asset management to evolve. The first is to standardize the framework and act of data collection. The analysis shows redundancy between interviews and document reviews, as responses from interviews commonly pointed to the review of specific public documents for more information. This analysis suggests that interviews are not necessary, as most municipalities publicize all work. The document review process is more accessible and time efficient as all relevant documents are publicly available through the municipalities' online domains. Indicators related to interview data can be removed from the existing evaluation matrix, standardizing the framework to be used solely for document reviews.

Another opportunity is to increase the clarity and specificity of the evaluation. A comparative analysis between the phases suggests that while municipalities are doing work in natural asset management, they may not identify this work as such, which may lead to under-

reporting of the pursuit of NAI objectives. Increasing clarity can take place in terms of language, as municipalities that use terms like natural assets, ecosystem services, or green infrastructure, display the most progress. Increased clarity and specificity also allow the research to utilize specific search terms across documents. This same clarity is also suggested for municipal natural asset management within provincial planning frameworks. For example, in Ontario, the current legislation for asset management defines green infrastructure assets that can be lumped into natural assets. However, this is ineffective, as only the use of specific definitions allows the incorporation of all ecological functions (Lam & Conway 2018). Policy at the municipal level should emphasise the differences between green infrastructure and natural asset management.

A final next step would be to consider the digitization of the evaluation, e.g., starting with the document review using machine learning technology for text analysis. An automated algorithm would be efficient at analyzing existing text data and producing dashboard-level results on program outcomes over time. Automating the process would also further reduce the potential for evaluator bias and reduce time requirements. An automated long-term monitoring and evaluation process could allow periodic, standardized re-evaluation of municipalities in a time-efficient manner. When consider the design of a potential application, common theme is the creation of a NAM database. There are three potential options of this approach, including (Yan et al, 2002; Persson, 2019; Hilton & Azzam, 2019):

1. Web Crawling consist of downloading webpages and storing this information in a host database. This process would still require an evaluator to review all the collected documents and extract connect but would reduce timeline of collecting data sources.

2. Web Scraping consist of extracting data from webpages and placing data in accordance with an identified indicator. Although more robust than web crawling,

this process is strenuous and costly, and would require an evaluator to review the finalized database of accuracy.

3. Crowdsourcing, a public method of collecting data that utilizes citizen information to form a database. Although cost and time efficient, this process would require public interest in NAM.

6.8 Conclusions

The purpose of this research was to evaluate the performance of municipal natural asset management programs by reviewing six case studies. As more local governments explore the potential benefits of municipal natural asset management, the Natural Assets Initiative has recognized the need for a monitoring framework to enhance evidence-collection efforts. The primary objective of the monitoring framework is to assess how municipalities are advancing in their municipal natural asset management programs relative to identified indicators. This focus is driven by the need to understand the changes in municipal operations resulting from a pilot program of municipal natural asset management. The methodology for evaluation consisted of a combination of document review and interviews carried out with program managers and directors. These documents and transcripts from the interviews were transferred into a database. Documents and interview transcripts from each municipality were then text-analyzed based on outcome and indicator categories defined in a program logic model and accompanying evaluation matrix. The results of the analyses led to the scoring of municipal operations using a five-point colour-coded scoring system.

Analysis of the results indicates that while many municipalities are increasing their awareness and capacity for natural asset management implementation, there are several challenges. These include a lack of knowledge of natural asset management, limited guidance of

policy change, and limited municipal resources. These challenges can inhibit long-term efforts in support of natural asset management. Municipalities can overcome these challenges by focusing on the enablers of natural asset management. The prime enabler of natural asset management is the municipal effort for climate change adaption and resiliency, supported by provincial interest and legislation for ecosystem valuation. Lastly, an increasingly engaged public might pressure municipalities to enhance the permanence of natural asset management efforts and require accountability for progress.

This research can be used by municipalities to make evidence-based decisions on their natural asset management efforts. This thesis provides insight to planners, policymakers, and researchers on the use of natural asset management and promotes efficient evaluation of their impacts on urban areas (Seddon et al., 2021). As natural asset management is designed to provide benefits for urban ecosystems, this research furthers the understanding of standardised evaluation criteria and the need for quantification of municipal service delivery.

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Appendix 1 – Evaluation Matrix

Evaluation Question/Problem	Indicator	Data Source	Analysis	Timing	Benchmarks
Are the municipalities meeting the awareness, capacity, and education outcomes? Goals: To ensure staff are operating with the appropriate awareness and education when beginning to implement municipal natural asset management (NAM). Further, they have established the appropriate capacity to integrate natural asset management (NAM).					
AC2 *Question 1 - Have municipal staff incorporated relevant local knowledge and concerns?*	Number of engagements with local sources of knowledge	Government records regarding engagements with local sources of knowledge (e.g., open houses, interviews, door- to-door campaigns)	Number of engagements that incorporate local sources of knowledge	After municipalities have established engagements	At least one (1) engagement with local sources of knowledge for each major program phase

AC2 *Question 2 - Have municipal staff partnered with academic institutions, relevant local non-government institutions, or private landowners?*	Number of formal and informal partnerships with academic institutions, relevant local non-governmental institutions, or private landowners	Local government records on formal and informal partnerships with academic institutions, relevant local NGOs, or private landowners	Number of formal and informal partnerships that involve academic institutions, relevant local non-governmental organizations, or private landowners	After municipalities have established said formal and informal partnerships	At least one (1) formal or informal partnership is with academic institutions, relevant local non-governmental organizations, or private landowners
AC3 *Question 1 - Have municipalities made the general public aware of natural asset management occurring?*	Number of townhalls, information sessions, and other general consultation events for NAM	Local government records and meeting minutes on public consultation efforts	Percentage of NAM consultation events with high attendance in comparison to other consultation events	After initial public consultation efforts and the dissemination of informational materials	More than 50% of NAM consultation events have a high attendance rate from local citizens
		Information materials disseminated to the public	Coded segments of information materials list importance of conducting NAM		All (100%) of information materials describe one reason for conducting NAM
To what extent is the program meeting implementation outcomes?					

Goals: To ensure proper changes and steps in planning and municipal development process to reflect the importance of NAM in municipal service delivery					
IL1 *Question 1 - Have the municipality and relevant stakeholders identified any barriers or opportunities to NAM within the municipality?*	Number of barriers or opportunities identified for NAM delivery within the municipality	Local government planning documents and stakeholder responses to NAM e.g.: White papers Technical reports Financial summaries Investigative journalism	Percentage of local government documents that clearly identify the issue of barriers and opportunities with specific examples	After awareness, capacity, and education outcomes	All (100%) of relevant local government documents identify barriers and opportunities and provide specific examples
IL1 *Question 2 - Have the municipality and relevant stakeholders acted upon identified barriers or opportunities to NAM within the project community?*	Number of identified barriers or opportunities acted upon for NAM delivery within the project community	Local government planning documents and stakeholder communications e.g.: White papers Technical reports SWOT Analysis	Coded segments of local government planning documents and stakeholder responses that detail actions taken for barriers or opportunities	After awareness, capacity, and education outcomes	At least one (1) high priority barrier or opportunity within organization's control is acted upon

IL2	Number of changes made to OP, ZBL, • Secondary Plans, etc.	Local government planning documents: - Asset Management Plan - Official Plan - Zoning By-law - Secondary Plans	Percentage of changes to local government planning documents to implement NAM	After initial implementation outcomes	All (100%) of relevant municipal planning policy documents changed to integrate NAM practices
Question 1 - Has the municipalities made changes to their OP, ZBL, Secondary Plans, etc.?					
IL3	Amount of funding and financing received for NAM projects	Project funding and financing documents from e.g.: - Insurance Sector - Banking Sector - Federal and Provincial Grant Applications	Calculation of funding available per project within the municipality	After changes made to relevant municipal planning policy documents	All (100%) of NAM projects have available funds in order to ensure a full lifecycle
Question 1 - Have new projects received funding or Financing?					

IL6 Question 1 - Have staff created new NAM policy, strategies, and plans?	Amount of funding budgeted for a municipal natural asset management program	Program and project funding allocated to NAM projects in: - Technical reports - Budgeting documents	Calculation of funding allocated per program and project within the community	After the creation of new NAM programs and projects	100% of NAM programs and projects are appropriately budgeted for year-over-year operations and management
Are municipalities on track to meet Ecosystem rehabilitation and Restoration outcomes? Goals: Once implementation has occurred, monitor natural assets and ecosystems to see increases in rehabilitation, restoration, or management metrics for natural asset health					
ER1 andER3 Question 1 -Are measurements or metrics being used for assessing ecosystem service quality?	Number of ecosystem service quality measurements or metrics within a municipal project area kept in the natural asset inventory	Records of ecosystem service measurements or metrics in a natural asset inventory	Percentage of major ecosystem services that are assessed with a measurement or metric	After the establishment of NAM policy, strategies, and plans	All (100%) of the major ecosystem services within a municipal area have measurements or metrics stored in a natural asset inventory

ER2 *Question 1 - Has the municipality created a rehabilitation or restoration project?*	Number of sites selected as potential rehabilitation or restoration project(s)	Municipal Planning Documents including, but not limited to: - Rehabilitation or Restoration Project Technical Report(s) - Environment and Lifecycle Assessments	Number of potential sites identified within the municipality	After initial measurements of ecosystem quantity and quality within the project community	Community has identified a (1) possible site for the creation of a NAM project that fits with larger NAM goals
ER1 *Question 2 - Where natural assets are intact and healthy, have the municipality created an operations and maintenance* *plan?*	Creation of an operations and maintenance plan	Municipal Planning Documents including, but not limited to: - NA Operations and Maintenance Plan	Coded segments of NAM planning documents that describe maintenance and operations	After initial measurements of ecosystem quantity and quality within the municipality	Local government has outlined a maintenance plan for the next 10 years
ER4 *Question 2 - Have the relevant indicators been measured and evaluated?*	Percentage change in relevant indicators identified for monitoring and evaluation	Municipal documents of completed evaluations	Coded segments of municipal documents that detail changes in relevant indicators	After the completion of the first evaluation	All (100%) of relevant indicators have been measured and evaluated

Are municipalities on track to meet service delivery outcomes?					
Goals: Once NAM projects have matured in their lifecycle, service delivery levels are met and benefits not possible with grey infrastructure are recorded.					
SD2 *Question 1 - Is there record of increased co-benefits?*	Percentage increase in co-benefits metrics monitored by the project community e.g., importance of CES as recreation	Records of increased use of natural areas e.g., for leisure, recreation after management or restoration	Calculation of the increase of co-benefits from natural asset management project(s)	After the implementation of NAM	Increase in co-benefits from natural asset management
SD3 *Question 1 - Has pressure been reduced on traditional municipal infrastructure that would have been impacted by climate change?*	Amount of municipal budget forecast to be spent on renewing grey infrastructure for climatic change	Interviews with Managers asking: "Do you expect less spending on municipal services because of the services provided by natural assets?"	Coded segments of interview responses which detail an expectation that spending will decrease due to municipal natural asset management	After the implementation of NAM policies and plans	Decrease in municipal budget forecasted to be spent on retrofitting and renewing grey infrastructure

Appendix 2 – Interview Questions

Questions that were applied within the evaluation matrix are highlighted using an (*). This is the original interview guide from phase 1.

AC1 Question 1 – Have relevant municipal staff been trained in natural asset management?

Interview Question: **How much training or education have municipal staff received on natural asset management and related concepts such as ecosystem services management?**

Who is this addressed to: Managers

Reasoning: **Our evaluation needs to know what training has prepared municipal staff to implement natural asset management. If the training was successful or has received positive feedback from managers and staff, then other municipalities should look to adopt similar training. Furthermore, we also want to compare training received with education levels of staff before implementing natural asset management to ensure that the project has a greater chance of success.**

Interview, Survey or Both: Interview

AC1 Question 2 – Have levels of education on natural assets increased among relevant municipal staff?

Interview Question: **What would you rate your staff's education level of natural asset management or related issues such as ecosystem services management? Why would you give this rating? Would you say there has been an increase in your staff's education level from when you first started this project?**

Who is this addressed to: Interview for Managers, Survey for Staff

Reasoning: **As stated in the question above, we want to be able to compare responses from the training question to levels of education to see where staff are being trained in natural asset management, and how effective that training is in delivering an increased education of key natural asset management concepts. As well, we also want to see if high education levels in natural assets lead to ease of implementation of natural asset management.**

Interview, Survey or Both: **Both – survey question could be a self-rating from staff while interview question for managers would be more generic and take an overview of the entire team/department.**

AC1 Question 3 – Have relevant municipal staff understood how the program can change their service delivery? **Interview Question:** Can you provide an example of how a natural area delivers a public service in your community? **Who is this addressed to:** Municipal staff

Reasoning: **This is a question to see if municipal staff understand the connection between municipal services and protecting natural assets. As well, this question may give insights on staff understanding of how municipal natural asset management operates in their municipality. Lastly, the details in their response may give some insights into their level of education on key concepts.**

Interview, Survey or Both: Interview

AC2 Question 1 – Have municipal staff incorporated relevant local knowledge and concerns?

Interview Question: **Are there specific local stakeholders with knowledge of your natural assets or ecosystem services? Have you engaged with them? Have they provided any input and how has this been addressed?**

Who is this addressed to: Managers

Reasoning: **Participatory approaches to environmental planning have proven to be highly effective, as shown in the literature. Therefore, project communities should look at engaging with local stakeholders who know their natural assets that municipalities have either not considered or have not been aware of. This could include private landowners, local climate scientists, activists, etc. As well, these stakeholders could be a potential barrier if their concerns go unheard in the education and capacity outcome stream.**

Interview, Survey or Both: Interview

*AC2 Question 2 – Have municipal staff partnered with academic institutions, relevant local non-government institutions, or private landowners? *

*Interview Question: **Are you aware of any partnerships or collaborations with other organizations to implement natural asset or ecosystem services management in your municipality? What kind of partnerships are these, who participates, and what are the benefits for the partners? ***

Who is this addressed to: Managers

Reasoning: **Although these partnerships may not be formal, it is important to be aware of who municipalities are working with, no matter the capacity. For example, some municipalities in Ontario may have partnerships with conservation authorities that are not available to**

municipalities in other provinces. If these partnerships are effective, they could be recommended for other municipalities in their relevant contexts.

Interview, Survey or Both: Interview

*AC3 Question 1 – Have the municipalities made the general public aware of natural asset management occurring? *

*Interview Question: **What public engagement efforts have you made to make the general public aware of natural asset or ecosystem services management?** *

Who is this addressed to: Managers

Reasoning: **Although we are not speaking to the general public on natural asset management occurring in their community, it is important to understand how the municipality is engaging with the public re changes and the reasoning for this. As well, knowing which engagement activities worked well may be useful for other municipalities.**

Interview, Survey or Both: **Both – Survey question could be "Select the kinds of public consultation efforts your municipality has made for making the public aware of natural asset management – open house, pamphlets, informational packets, etc."**

**IL1 Question 1 – Have the municipality and relevant stakeholders identified any barriers or opportunities to NAM within the project community? * *

*Interview Question: **Are there any barriers or opportunities that the municipality or your partners have encountered when attempting to implement municipal natural asset or ecosystem services management? Did you act upon these? How did you do that?** *

Who is this addressed to: Managers

Reasoning: **We have previous research completed on this very subject, but it is important to compare that research to the experiences of project communities and whether there is any new information on this subject. We should also acknowledge that our prior work might not have covered all barriers and opportunities. As well, insights on this topic should be shared with other municipalities that encounter similar barriers or opportunities.**

Interview, Survey or Both: Interview

IL1 Question 2 – Have the municipality and relevant stakeholders acted upon identified barriers or opportunities to NAM within the project community?

Interview Question: **Not needed as a separate interview question – potential answers are covered in interview question IL1 Q1.**

Who is this addressed to: N/A

Reasoning: N/A

Interview, Survey or Both: N/A

IL2 Question 1 – Can the municipality draw on any alignment of natural assets management with existing policy and initiatives?

Interview Question: **Can you name and explain at least one existing municipal policy initiative or planning goal that natural asset or ecosystem services management aligns with in your community?**

Who is this addressed to: Managers

Reasoning: **This question not only looks to see if there is alignment for implementing natural asset management but if project communities are already thinking of climate resilience in their municipal planning. If climate resilience is already a serious policy issue for the municipality, there may be more instances of alignment, and therefore, ease of implementation.**

Interview, Survey or Both: Interview

*IL3 Question 1 – Has the municipality made changes to their Official Plan, Zoning By-law, Secondary Plans, etc.to accommodate natural asset or ecosystem services management? *

*Interview Question: **What changes, if any, has your municipality made to implement natural asset or ecosystem services management into your municipal planning policy, such as your Official Plan, By-laws, etc.? ***

Who is this addressed to: Managers

Reasoning: **For implementation to occur on a comprehensive level, measured changes need to be made to appropriate policies. While each municipality's official plan or zoning by-law will be different, similar changes could be adopted by other municipalities.**

Furthermore, responses to these changes from the public could provide additional insights.

Interview, Survey or Both: Interview

*IL4 Question 1 – Have new projects received funding or financing? *

*Interview Question: **Have natural asset or ecosystem services management projects received funding or financing? Was this funding or financing sufficient to complete the project as planned? From where did the funding or financing come? ***

Who is this addressed to: Managers

Reasoning: **Although specifics may be difficult to provide, how much funding projects have to work with and where this funding was provided from will not only aid other municipalities looking to start municipal natural asset management but can also lead to other research opportunities. These research opportunities include investment patterns, investment structures, and willingness-to-pay studies. As well, exploring available funding opportunities can show potential financiers where there are existing gaps. Finally, the level of funding relative to the required funds could contribute to an understanding of project success.**

Interview, Survey or Both: Interview

IL5 Question 1 – Has funding or financing been applied to the creation of new natural asset management programs or plans?

Interview Question: **Has the municipality funding budgeted to implement a new natural asset or ecosystem services management program or plan? What kinds of programs or plans are these and what aspects of these programs or plans are funded?**

Who is this addressed to: Managers

Reasoning: **Although much of this question may be covered by internal municipal planning documents, the second part of the interview question could be critical. Determining where the most amount of funding is needed and how municipalities are approaching budgeting for**

natural asset management could yield insights on where investments are needed on a program-level. This question goes beyond IL5 Q1 as budgeting should extend beyond individual project implementation to the larger program level.

Interview, Survey or Both: Interview

*IL6 Question 1 – Have staff implemented new NAM programs or plans? *

*Interview Question: **Has the municipality implemented, or is currently implementing, natural asset or ecosystem services management programs or plans? ***

Who is this addressed to: Managers

Reasoning: **This question goes beyond IL6 Q1 is addressing whether natural asset or ecosystem services management programs or plans actually are being carried out. Answers to this question might already be provided during IL6 Q1 or the answer to IL6 Q1 might have been 'no' in which case this question could be skipped.**

Interview, Survey or Both: Interview

*ER1 and ER3 Question 1 – Are measurements or metrics being used for assessing ecosystem service quality changes from before to after ecosystem rehabilitation or restoration? *

*Interview Question: **Can you name and describe a metric the municipality is using to monitor ecosystem service quality improvements achieved through an ecosystem rehabilitation or restoration project? ***

Who is this addressed to: Manager

Reasoning: **This interview question tries to gain insight on several key areas in ecosystem rehabilitation and restoration. The first area is what qualitative or quantitative metrics municipalities are using. The second, which is much more subtle, is what metrics are most important to the municipality, and thus, the first to come to mind during an interview. A ranking of metrics could provide information on what ecosystem services municipalities are focusing on and why. The third area is whether municipalities are assessing ecosystem rehabilitation and restoration outcomes at all to establish whether the project was successful.**

Interview, Survey or Both: **Both – this same question could be included on a survey as a fill-in-the-blank or as a choice amongst several.**

ER1 and ER3 Question 2 – How many natural asset areas that have been rehabilitated or restore have measurements been taken from?

Interview Question: **How many and which natural asset areas or ecosystems that have been rehabilitated or restored is your municipality monitoring?**

Who is this addressed to: Managers

Reasoning: **Ultimately, one of the goals of NAI is to protect and conserve as many natural areas as possible from degradation. Therefore, NAI will want to know how many natural assets municipalities are protecting, restoring, or rehabilitating. However, this answer could also be contingent on an existing green infrastructure network, the urban density of the project community, and the availability of natural assets within municipal boundaries. All these considerations will be a part of the answers here and lead to additional insights for the evaluation.**

Interview, Survey or Both: **Both – could work as a survey question for managers as well, same question, given a range for a number of areas (1-5, 5-10, 10-15, etc.)**

*ER2 Question 1 – Has the municipality created rehabilitation or restoration projects? *

*Interview Question: **Did the municipality conducted natural asset or ecosystem rehabilitation or restoration projects? Why did the municipality select these areas for rehabilitation or restoration?** *

Who is this addressed to: Managers

Reasoning: **As we address in the next evaluation and interview question, not all natural assets require restoration or rehabilitation. However, understanding the reasoning behind why a site was selected for rehabilitation or restoration is important as it could demonstrate the kinds of decisions municipalities make in these areas. This could include service delivery, ease of restoration or rehabilitation, cost, etc.**

Interview, Survey or Both: Interview

ER2 Question 2 – Where natural assets are intact and healthy, has the municipality created an operations and maintenance plan?

Interview Question: Does the municipality have in place monitoring and maintenance plans for healthy natural assets or ecosystems?

Who is this addressed to: Managers

Reasoning: **This question would be for project communities who already have healthy natural assets and inquires whether they have created an operations and maintenance plan. This question aims at covering the whole natural asset portfolio of the municipality, not just the assets that require restoration or rehabilitation as in ER2 Q1.**

Interview, Survey or Both: Interview

ER3 Question 1 – Is the quality of ecosystem services improving?

Interview Question: **Have you seen an improvement in the metrics your team or municipality is using to monitor ecosystem service quality?**

Who is this addressed to: Managers

Reasoning: **This question complements question ER1 & ER3 Q1. It focuses on whether the ecosystem rehabilitation and restoration projects were successful in improving natural asset health and ecosystem services delivery. As well, this question also addresses the metrics selected for measurement. What we would be looking for is not only an improvement in key metrics but what metrics are improving and by how much. This could provide critical information for other municipalities looking to start their natural asset management journey.**

Interview, Survey or Both: Interview

ER4 Question 1 – Has the monitoring of natural assets and ecosystem services occurred?

Interview Question: **Has the municipality monitoring plans in place for the services produced by its natural assets or ecosystems?**

Who is this addressed to: Managers

Reasoning: **While we are creating an evaluation framework here, we want municipalities to commit to a monitoring framework as these projects evolve over the decades. If these monitoring frameworks are successful in their municipalities, we should look to translate them into other project communities. Different from ER1 & ER3 Q1, this question is not focused on rehabilitation or restoration project outcomes but service delivery by natural assets or ecosystems over the longer term.**

Interview, Survey or Both: Interview

*ER4 Question 2 – Which indicators are being used for the monitoring of natural assets and ecosystem services and have the indicators been evaluated? *

Interview Question: Which indicators is the municipality using for the monitoring of its *natural assets and ecosystem services*? How have these indictors been decided upon and evaluated for usefulness? *

Who is this addressed to: Managers

Reasoning: **This question would be a follow-up to the interview question for ER4 Question 1. The indicators used for evaluation and monitoring could inform how effective these approaches are and whether changes need to occur, especially if the municipality is unfamiliar with program or plan evaluation. As well, if the municipality is familiar with program or plan evaluation, their approach could be beneficial for other project communities starting their natural asset management journey.**

Interview, Survey or Both: Interview

ER5 Question 1 – Has the condition of natural assets or ecosystems improved based on projects and subsequent land-use changes?

Interview Question: **Has the condition of natural assets or ecosystems in the municipality improved? Which actions at the operational or policy level have led to this?**

Who is this addressed to: Managers

Reasoning: **Overlapping with ER3 Q1 but at a larger scale. ER3 Q1 aims at individual ecosystems while the current questions aim at the landscape-scale. While this study may not have the capacity to verify or compare this improvement to a standard, it does provide insight on what kinds of actions project communities are using and whether other municipalities could also use these actions.**

Interview, Survey or Both: Interview

SD1 Question 1 – Due to the rehabilitation and restoration project, are desired sustainable service levels being reached?

Interview Question: **Has the delivery of municipal services in your community changed since implementing natural asset or ecosystem services management? If it has improved, has natural asset or ecosystem services management contributed to this improvement?**

Who is this addressed to: Manager or municipal staff

Reasoning: **While this question could work as just an interview question for managers, a survey question allows us to reach a larger number of staff who may have received more feedback from users, residents, or other stakeholders. As well, one natural asset area may provide several services that can go beyond the scope of one department. However, as a survey question, we lose the ability to ask what municipal services specifically or how staff understand "improvement".**

Interview, Survey or Both: Both

*SD2 Question 1 – Is there record of increased co-benefits? *

*Interview Question: **Are you monitoring any co-benefits of natural asset or ecosystem services management? Is there evidence of such co-benefits occurring? ***

Who is this addressed to: Managers

Reasoning: **This question has several different threads it can follow, just based on the sheer number of co-benefits offered by natural assets. However, there may be a select number of co-benefits that most project communities are focusing on, specifically around regulating ecosystem services and cultural ecosystem services. While not the focus of this research, these co-benefits may provide additional insight. As well, the performance of these benefits could also provide evidence for the usefulness of natural asset management. Having said that, these co-benefits might be difficult to establish and connect to natural asset management.**

Interview, Survey or Both: Interview

SD2 Question 2 – Is there record of decreased negative effects of urbanization or environmental degradation?

Interview Question: **Are there any negative effects of urbanization or environmental degradation you are monitoring? Is there evidence of these negative effects decreasing because of natural assets or ecosystem services management?**

Who is this addressed to: Managers

Reasoning: **Like SD2 Q1, this interview question follows similar reasoning. For example, there could be several negative effects of urbanization or other environmental degradation, but municipalities may only be monitoring a select few that are the most concerning. The insights from this question could also warrant additional research on this topic. Having said that, a decrease in these negative effects might be difficult to establish and connect to natural asset management.**

Interview, Survey or Both: Interview

*SD3 Question 1 – Has pressure been reduced on traditional municipal infrastructure that would have been impacted by climate change? **

*Interview Question: **Are spending increases on municipal services due to climate change been limited because of the services provided by natural assets or ecosystems? ***

Who is this addressed to: Managers

Reasoning: **While our evaluation question may be difficult to get a complete answer for, this interview question can provide some insights on how natural asset management is changing service delivery in project communities in the current climate change context.**

Specifically, if municipalities are expecting to spend less on municipal services, natural asset management could be providing similar services for that cost.

Interview, Survey or Both: Interview

SD4 Question 1 – Are municipalities measuring and reviewing progress to their service delivery?

Interview Question: **Are you, or are you intending to, monitor progress in your municipal service delivery with natural asset or ecosystem services management? What are the results of this monitoring thus far?**

Who is this addressed to: Managers

Reasoning: **One of the intended goals of NAI is the independent progress of municipalities in NAM. Part of our evaluation should look to see what municipalities have planned to do after the conclusion of their pilot project in the long run. As well, we would also want to see if municipalities will share that information not only with us as the evaluators but with other municipalities interested in natural asset management.**

Interview, Survey or Both: Interview.

Appendix 3 – Individual Scorecards

Awareness, Capacity and Education Indicators

Number of general consultation efforts for NAM
Benchmark 1:
More than 50% of NAM Consultation events have a high attendance rate
Benchmark 2:
All [100%] of information materials describe one reason for conducting MNAM

Number of formal and informal partnerships with academic institutions, relevant local nongovernmental institutions, or private landowners
At least 1 formal or informal partnership

Implementation Indicators

Number of barriers or opportunities identified in MNAM delivery within the project community
Benchmark 1: 100% of relevant documents identify barriers and opportunities.

Number of changes made to OP, ZBL, Secondary Plans, etc.
All [100%] of relevant municipal planning policy changed to integrate MNAN

Amount of funding and financing received for projects
All [100%] of projects and programs have available funds to ensure a full lifecycle

Number of new NAM policy, strategies, and plans
All [100%] of NAM policy, strategies, and plans created to support MNAM

Ecosystem Rehabilitation and Restoration Indicators

Number of ecosystem service quality measurements or metrics within project community area kept in the natural asset inventory
All [100%] of the major municipal ecosystem services have measurements/metrics available in NA inventory

Number of sites selected as potential rehabilitation or restoration projects.
Community has identified a possible site for the creation of a NAM project that fits with larger NAM goals

Number of relevant indicators identified for monitoring and evaluation.
Municipality has identified at least one key indicator for the lifecycle of NAM projects

Service Deliver Indicators

Percentage increase in co-benefit metrics monitored by project community
Increase in co-benefits from natural asset management

Amount of municipal budget forecast to be spent on renewing grey infrastructure for climatic change
Decrease in municipal budget forecasted to be spent on retrofitting and renewing grey infrastructure

Figure 10. Balanced Scorecard for Town of Florenceville-Bristol

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Awareness, Capacity and Education Indicators

Number of general consultation efforts for NAM
Benchmark 1:
More than 50% of NAM Consultation events have a high attendance rate
Benchmark 2:
All [100%] of information materials describe one reason for conducting MNAM

Number of formal and informal partnerships with academic institutions, relevant local nongovernmental institutions, or private landowners
At least 1 formal or informal partnership

Implementation Indicators

Number of barriers or opportunities identified in MNAM delivery within the project community
Benchmark 1: 100% of relevant documents identify barriers and opportunities.

Number of changes made to OP, ZBL, Secondary Plans, etc.
All [100%] of relevant municipal planning policy changed to integrate MNAN

Amount of funding and financing received for projects
All [100%] of projects and programs have available funds to ensure a full lifecycle

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All [100%] of NAM policy, strategies, and plans created to support MNAM

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All [100%] of the major municipal ecosystem services have measurements/metrics available in NA inventory

Number of sites selected as potential rehabilitation or restoration projects.
Community has identified a possible site for the creation of a NAM project that fits with larger NAM goals

Number of relevant indicators identified for monitoring and evaluation.
Municipality has identified at least one key indicator for the lifecycle of NAM projects

Service Deliver Indicators

Percentage increase in co-benefit metrics monitored by project community
Increase in co-benefits from natural asset management

Amount of municipal budget forecast to be spent on renewing grey infrastructure for climatic change
Decrease in municipal budget forecasted to be spent on retrofitting and renewing grey infrastructure

Figure 11. Balanced Scorecard for the Southeast Regional Service Commission (SERSC))

Awareness, Capacity and Education Indicators

Number of general consultation efforts for NAM
Benchmark 1:
More than 50% of NAM Consultation events have a high attendance rate
Benchmark 2:
All [100%] of information materials describe one reason for conducting MNAM

Number of formal and informal partnerships with academic institutions, relevant local nongovernmental institutions, or private landowners
At least 1 formal or informal partnership

Implementation Indicators

Number of barriers or opportunities identified in MNAM delivery within the project community
Benchmark 1: 100% of relevant documents identify barriers and opportunities.

Number of changes made to OP, ZBL, Secondary Plans, etc.
All [100%] of relevant municipal planning policy changed to integrate MNAN

Amount of funding and financing received for projects
All [100%] of projects and programs have available funds to ensure a full lifecycle

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All [100%] of NAM policy, strategies, and plans created to support MNAM

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Number of relevant indicators identified for monitoring and evaluation.
Municipality has identified at least one key indicator for the lifecycle of NAM projects

Service Deliver Indicators

Percentage increase in co-benefit metrics monitored by project community
Increase in co-benefits from natural asset management

Amount of municipal budget forecast to be spent on renewing grey infrastructure for climatic change
Decrease in municipal budget forecasted to be spent on retrofitting and renewing grey infrastructure

Figure 12. Balanced scorecard for District of Sparwood

Awareness, Capacity and Education Indicators

Number of general consultation efforts for NAM
Benchmark 1:
More than 50% of NAM Consultation events have a high attendance rate
Benchmark 2:
All [100%] of information materials describe one reason for conducting MNAM

Number of formal and informal partnerships with academic institutions, relevant local nongovernmental institutions, or private landowners
At least 1 formal or informal partnership

Implementation Indicators

Number of barriers or opportunities identified in MNAM delivery within the project community
Benchmark 1: 100% of relevant documents identify barriers and opportunities.

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Amount of funding and financing received for projects
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Number of new NAM policy, strategies, and plans
All [100%] of NAM policy, strategies, and plans created to support MNAM

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All [100%] of the major municipal ecosystem services have measurements/metrics available in NA inventory

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Community has identified a possible site for the creation of a NAM project that fits with larger NAM goals

Number of relevant indicators identified for monitoring and evaluation.
Municipality has identified at least one key indicator for the lifecycle of NAM projects

Service Deliver Indicators

Percentage increase in co-benefit metrics monitored by project community
Increase in co-benefits from natural asset management

Amount of municipal budget forecast to be spent on renewing grey infrastructure for climatic change
Decrease in municipal budget forecasted to be spent on retrofitting and renewing grey infrastructure

Figure 13. Balanced scorecard for City of Courtenay

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Awareness, Capacity and Education Indicators

Number of general consultation efforts for NAM
Benchmark 1:
More than 50% of NAM Consultation events have a high attendance rate
Benchmark 2:
All [100%] of information materials describe one reason for conducting MNAM

Number of formal and informal partnerships with academic institutions, relevant local nongovernmental institutions, or private landowners
At least 1 formal or informal partnership

Implementation Indicators

Number of barriers or opportunities identified in MNAM delivery within the project community
Benchmark 1: 100% of relevant documents identify barriers and opportunities.

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All [100%] of relevant municipal planning policy changed to integrate MNAN

Amount of funding and financing received for projects
All [100%] of projects and programs have available funds to ensure a full lifecycle

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All [100%] of the major municipal ecosystem services have measurements/metrics available in NA inventory

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Number of relevant indicators identified for monitoring and evaluation.
Municipality has identified at least one key indicator for the lifecycle of NAM projects

Service Deliver Indicators

Percentage increase in co-benefit metrics monitored by project community
Increase in co-benefits from natural asset management

Amount of municipal budget forecast to be spent on renewing grey infrastructure for climatic change
Decrease in municipal budget forecasted to be spent on retrofitting and renewing grey infrastructure

Figure 14. Balanced Scorecard for City of Oshawa

Awareness, Capacity and Education Indicators

Number of general consultation efforts for NAM
Benchmark 1:
More than 50% of NAM Consultation events have a high attendance rate
Benchmark 2:
All [100%] of information materials describe one reason for conducting MNAM

Number of formal and informal partnerships with academic institutions, relevant local nongovernmental institutions, or private landowners
At least 1 formal or informal partnership

Implementation Indicators

Number of barriers or opportunities identified in MNAM delivery within the project community
Benchmark 1: 100% of relevant documents identify barriers and opportunities.

Number of changes made to OP, ZBL, Secondary Plans, etc.
All [100%] of relevant municipal planning policy changed to integrate MNAN

Amount of funding and financing received for projects
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Number of new NAM policy, strategies, and plans
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Number of sites selected as potential rehabilitation or restoration projects.
Community has identified a possible site for the creation of a NAM project that fits with larger NAM goals

Number of relevant indicators identified for monitoring and evaluation.
Municipality has identified at least one key indicator for the lifecycle of NAM projects

Service Deliver Indicators

Percentage increase in co-benefit metrics monitored by project community
Increase in co-benefits from natural asset management

Amount of municipal budget forecast to be spent on renewing grey infrastructure for climatic change
Decrease in municipal budget forecasted to be spent on retrofitting and renewing grey infrastructure

Figure 15. Balanced scorecard for Region of Peel