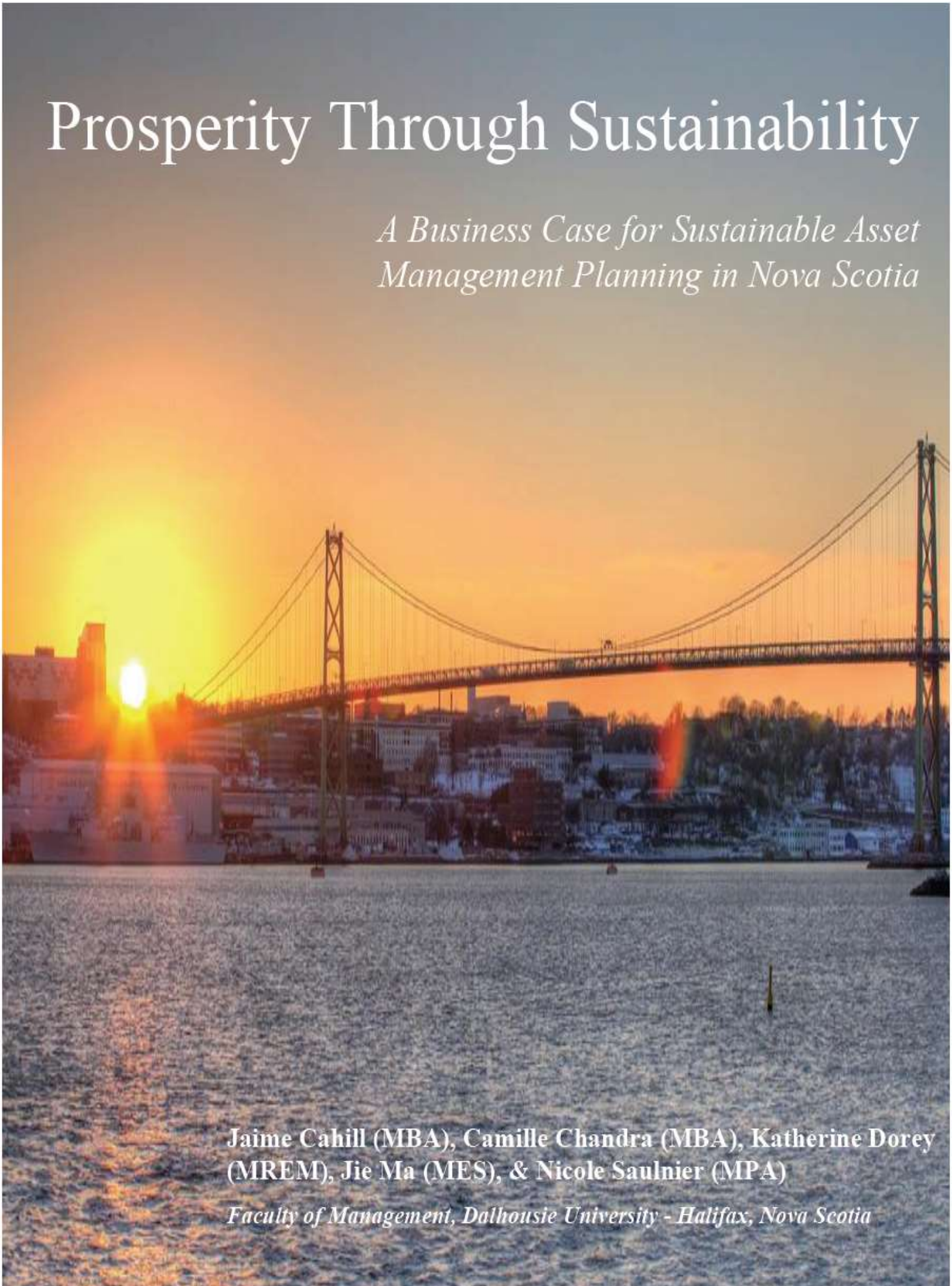
Prosperity Through Sustainability

A Business Case for Sustainable Asset Management Planning in Nova Scotia



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Executive Summary

Municipal infrastructure provides the daily services that Nova Scotians depend on such as safe drinking water, waste disposal, recreation facilities, and protection from floods and other natural disasters (CIRC, 2016). With various priorities competing for public funding, spending on municipal infrastructure in Canada has declined, threatening the physical condition of these assets and increasing the impending cost of renewal (CIRC, 2016). In order to "meet the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 8), municipalities need to develop sustainable asset management plans.

The purpose of this research study is to develop a business case for Nova Scotia municipalities to adopt asset management planning, encourage the incorporation of sustainability, and highlight recommendations for implementation. The project was completed in partnership with the Union of Nova Scotia Municipalities (UNSM), a not-for-profit organization representing municipal interests across the province. UNSM provides many resources to help municipalities reach targets and receive funding, and asset management is becoming increasingly important as infrastructure in the province ages.

Data was collected via three methods: conduction and analysis of interviews with industry professionals, analysis of literature reviews, and examination of case studies. The interview participants partook anonymously, and responses were analyzed using Nvivo coding software. Literature reviews inclusive of websites, reports, and published articles provided thorough background information on asset management planning and sustainability, and case studies offered practical examples and best practices. The four municipalities studied were identified for adopting sustainable practices in infrastructure planning.

Analysis of the data collected revealed several benefits municipalities experience by adopting sustainable asset management plans. Environmentally, adapting assets to withstand effects of climate change is hugely beneficial for municipalities, and critical for coastal communities more susceptible to threats of climate change. Economically the long-term savings of reinvesting in infrastructure outweigh the short-term capital cost, particularly when considering the growth of Gross Domestic Product from infrastructure industries, as well as job creation. Politically, there is incentive for municipalities to act sooner than later and reap the benefits of government funding as well as avoid negative repercussions if mandatory asset management planning requirements are instated.

The research study also pointed to several key challenges that municipalities could face in the development and implementation of sustainable asset management planning. Firstly, municipalities may be forced to revisit how their assets are managed. Typically, assets are organized by class, placing accountability on specific departments, but this method creates inefficiencies in a system that should be viewed holistically considering the long-term life cycles of assets. Secondly, the decision-making process itself becomes a challenge as the life cycle of assets extends well beyond terms of elected officials and goals for the environment and the economy often conflict. This disconnect in the collective understanding of long-term benefits versus the demand municipalities have for short-term results outlines the third challenge identified from data analysis,

which is motivation. And lastly, capacity is a significant challenge in almost all communities. Many municipalities simply do not have the financial or the human resources to implement asset management planning effectively.

Based on this analysis several key considerations for developing sustainable asset management planning were identified. Firstly, municipalities need to understand the vulnerability of their environment to climate change, and prioritize efforts to decrease emissions and conserve resources. Secondly, stakeholders need to remain tolerant throughout planning. It is a lengthy process, which requires cross-boundary collaboration among various stakeholders including employees of specific municipal departments, members of the community, and elected officials. Evidently, the development of sustainable asset management plans must be formed at a high level in order to strategically coordinate asset management. Thirdly, municipalities must consider creating a public platform allowing municipalities to share their experiences and communicate ideas. Finally, conducting a life cycle cost analysis of assets is a useful tool that helps municipalities decide upon investment timelines and realize cost savings.

These key considerations defined the report's five recommendations:

Recommendation #1: Municipalities create and implement public education sessions with a focus on teaching the importance of sustainable asset management for responsible service delivery.

Recommendation #2: UNSM construct a platform or method for municipalities to share sustainable infrastructure practices and lessons learned for other municipalities to learn from.

Recommendation #3: Municipalities consider the use of sustainability tools to guide and support their asset management planning such as the Green Municipal and Small Community Infrastructure Funding opportunities, Envision, LEED, and EPEAT evaluation frameworks, and other sustainable procurement policies.

Recommendation #4: Municipalities prioritize adaptations, maintenance, and renewals for infrastructure assets that are vulnerable to climate change to ensure it is adapting in time to reduce financial risks associated with climate change damage.

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Acronyms

BC	British Columbia
CNAM	Canadian National Asset Managers
CIRC	Canadian Infrastructure Report Card
EPEAT	Environmental Product Environmental Assessment Tool
FCM	Federation of Canadian Municipalities
FGTF	Federal Gas Tax Fund
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GMF	Green Municipal Fund
ICSP	Integrated Community Sustainability Plan
LAMP	Leadership in Asset Management Program
LEED	Leadership in Energy and Environmental Design
MCSP	Municipal Collaboration for Sustainable Procurement
MCCAP	Municipal Climate Change Action Plan
NB	New Brunswick
NS	Nova Scotia
ON	Ontario
PSAB	Public Sector Accounting Boards
SCIF	Small Community Infrastructure Fund
UNSM	Union of Nova Scotia Municipalities

Definitions

Assets	Municipal infrastructure (e.g., buildings, sidewalks, water, and wastewater systems, etc.)
Sustainability	"[M]eeting the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 8)
Asset Management Plan	Document that "supports integrated lifecycle approaches to effective stewardship of infrastructure assets in order to maximize benefits and manage risks" (Government of Canada, 2014, Annex A).

1.0 Project Objectives

Five graduate students from Dalhousie's Faculty of Management (Resource and Environmental Management, Environmental Science, Public Administration, and Business Administration) worked in collaboration with Union of Nova Scotia Municipalities (UNSM) to investigate sustainability as a key component of asset management planning. The findings of this project are both timely and of paramount importance for two reasons: a recent implementation of a Federal Gas Tax Fund (FGTF) in Nova Scotia (Province of NS, 2015a), and the large infrastructure deficit being experienced by the province (Gagnon, 2008; Mirza, 2007). Despite the implementation of the FGTF, many municipalities are not actively engaging in sustainable infrastructure practices (CIRC, 2016).

The purpose of this project is to develop a business case for sustainable asset management planning to encourage municipalities to incorporate sustainability into their plans and highlight recommendations for how they can work towards implementation today (MWB, 2016). This study investigated the environmental, economic, and social benefits as well as challenges associated with sustainable asset management planning. This study also determined what steps municipalities can start taking towards implementing such techniques. To develop the most beneficial recommendations for municipalities, this project will be focused around two overarching research questions. What are the reasons that municipalities should adopt sustainable asset management? How can municipalities begin to implement sustainable asset management today?

2.0 Introduction

The province of Nova Scotia (NS) is comprised of 50 municipalities (UNSM, 2016, n.p). The municipalities derive their legislative and governing authority from the provincial *Municipal Government Act* (1998). This *Act* is a provincial law empowering municipalities with governance authority and requiring certain services be delivered. To properly deliver these services, municipalities must develop and maintain infrastructure including buildings, water treatment facilities, wastewater systems, water distribution networks, roads, sidewalks, paths, bridges, landfills, culverts, equipment, and streetlights (UNSM, n.d.a). However, aging infrastructure places a heavy burden on municipalities to keep track of maintenance and gather funding for large projects. To aid municipalities with this task, the FGTF is a federal program, but administered by the province, for municipal infrastructure projects that fall within 18 categories (e.g., wastewater, local roads and bridges, tourism infrastructure, disaster mitigation) (Province of NS, 2015a). The 2014-2024 FGTF Administrative Agreement has requirements that must be met by municipalities in order to access these funds. One of the requirements for this funding includes demonstrating progress towards developing and/or implementing an asset management plans (Government of Canada, 2014).

The remainder of this report will demonstrate the importance of developing and implementing asset management plans for NS Municipalities with a focus on sustainability. In the face of aging infrastructure and a pressure to conserve energy while adapting to climate change, municipalities must take steps towards sustainable asset management to provide reliable, fiscally-responsible service delivery.

2.1 Asset Management Plan

An asset management plan, as defined in the Municipal Funding Agreement, is a document that "supports integrated lifecycle approaches to effective stewardship of infrastructure assets in order to maximize benefits and manage risks" (Government of Canada, 2014, Annex A). To fulfill requirements of an asset management plan municipalities must, at minimum, create an inventory of all infrastructural assets and their current condition.

Asset management aims to identify asset life cycles and considers the maintenance, rehabilitation, and replacement of all municipal infrastructure. In other words, it is a way for municipalities to be proactive rather than reactive: knowing the current state of infrastructure, including what needs to be repaired, what is most pressing, and what are the costs of repairs. This awareness will prevent service disruptions, provide more predictable results, and lower the total life cycle costs of assets while extending their life through proper reinvestment and maintenance (Foster, 2016).

Foster (2016) suggests that when beginning asset management, municipalities and organizations should answer three questions: "What services are being provided now, what services will be provided in the future, and what level of services does our community value?" (slide 16). From these questions, municipalities can determine the desired level of service and affordability. Once desired service delivery is established, municipalities should create an asset inventory of everything the municipality owns, their locations, and worth (e.g. construction costs and replacement value). The next step in asset management is to assess the condition of the asset and to determine the life remaining in the asset before renewal is needed. From all of the information gathered, municipalities should identify the total cost to repair and renew all assets to bring service delivery to the desired level. This information can then be used to determine what infrastructure needs to be repaired or replaced, which will inform municipalities on how to achieve the desired level of service delivery in a cost-effective manner (Foster, 2015).

Throughout Canada, 62% of large municipalities, 56% of medium-sized municipalities, and 35% of small municipalities have developed some form of an asset management plan (CIRC, 2016, p.14). As the majority of NS municipalities are small and rural compared to the rest of Canada, many municipalities could benefit from developing an asset management plan. This benefit is especially true since according to the Canadian Infrastructure Report Card (CIRC) (2016) only 10% of small municipalities have developed a state of infrastructure report (p.14).

2.2 The Need for Asset Management

Municipal infrastructure provides the daily services that Nova Scotians depend on such as safe drinking water, waste disposal, recreation facilities, and protection from floods and other natural disasters (CIRC, 2016). In the 19th century, Canada was strongly dedicated to providing public infrastructure including roads, canals, and railways. Following this technological development, in the 20th century, Canada had a new industrial reality that required electrification, safe drinking water, waste management, and public transit to support cities and communities. This "Golden Age" of Canadian infrastructure followed the Second World War with high investments in municipal infrastructure to support development (CIRC, 2016, p.8). However, near the end of the

20th century a decline in spending on public infrastructure occurred due to competing priorities during the economic growth of the post-war era (CIRC, 2016). This decline in infrastructure reinvestment rates has led to an overall decline in the physical condition of infrastructure and the cost of renewing these aging assets has become a concern for all of Canada. In addition to aging infrastructure, municipalities are also facing new challenges such as climate change, and environmental legislation requiring upgrades to older water, sewer, and energy systems (CIRC, 2016).

According to the CIRC (2016), one-third of all municipal infrastructure is said to be in "fair, poor, or very poor condition greatly increasing risk associated with service delivery" (p. 10). Mirza (2007) places Canada's infrastructure deficit around $123 billion (p. 2). Furthermore, as of 2007, NS faced even greater challenges with the oldest average age of infrastructure in Canada (Gagnon et al., 2008). Gagnon et al. (2008) studied five different assets including, roads including highways, bridges including overpasses, water supply systems, wastewater treatment facilities, and sewer systems to determine age trends among Canada. In 2003, NS infrastructure reached an average age of 19.2 years. However, with more recent investment this average was brought down to 18 years in 2007, but still remains above the Canadian average (Gagnon et al., 2008, p. 13). Asset management in NS will help reduce the average age of infrastructure by identifying the age and condition of all assets and supporting municipalities to prioritize maintenance and renewal.

2.3 Incorporating Sustainability

Sustainability can have many definitions, but is widely referred to as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 8). NS municipalities must adopt sustainable principles during development to ensure the province's level of service delivery continues to meet the needs of residents for both current and future generations. Managing municipal assets sustainably during retrofitting and renewals is important to ensuring municipalities reduce their energy consumption and greenhouse gas (GHG) emissions. In Canada, municipalities are responsible for 44% of emissions through daily services such as water, health care, recreation, waste management, and streetlights (Stantec, 2011, p. 3). With a heavy reliance on coal for energy production in NS, implementing sustainable practices during infrastructure development would be highly beneficial towards meeting provincial emissions reduction goals of 10% below 1990 levels (EGSPA, 2007, n.p).

With a large infrastructural deficit in Canada, there is no doubt that Nova Scotia follows this trend with some of the oldest infrastructure in the country. The Federation of Canadian Municipalities (FCM) estimated 79% of the life of Canadian infrastructure has been spent suggesting that large renewal and maintenance projects will be needed in the near future (Mirza, 2007, p. 10). Participating in asset management will help municipalities reduce this deficit and provides an exciting opportunity to implement sustainable infrastructure and practices during renewal and retrofitting. Incorporating sustainability will provide cost-savings, reduce energy consumption, and lower impacts on the environment (Province of NS, 2014a).

Sustainable asset management can help municipalities reach goals set out in their Integrated Community Sustainability Plans (ICSP). Municipalities already have a clear vision of sustainability for their communities and asset management provides a way that they can begin implementing their visions by making their infrastructure, energy use, and product procurement more sustainable. Furthermore, a core component of the ICSP was to link the plan to sustainable infrastructure, which encourages the end goal of sustainable asset management (Province of NS, 2015c).

The pressure to implement sustainability in all development initiatives is often seen as a financial burden. Many small municipalities do not have the financial or human capital to incorporate the level of effort needed to make real change towards a sustainable future. However, many municipalities may not realize that although the upfront costs of sustainability can be more than more traditional materials and practices, cost-savings are realized over the long term (Province of NS, 2014a). Furthermore, there are many different funding programs in place to help municipalities achieve sustainable development.

2.3.1 Funding Programs

Green Municipal Fund and Leadership in Asset Management Program:

The Green Municipal Fund (GMF) is a program delivered by FCM to provide funding and support towards sustainable community development. The GMF supports three types of environmental initiatives including plans, studies, and projects in five different sectors: brownfield, energy, transportation, waste, and water. The funding requires that the initiatives improve air, water, or soil quality, and/or mitigate climate change impacts (FCM, 2016a).

A major initiative funded by the GMF in the Leadership in Asset Management Program (LAMP). Recently, 12 Canadian municipalities were granted a total of $1,028,835 to support asset management and sustainability efforts (FCM, 2016b, n.p). LAMP provides funding for municipalities to make better decisions about infrastructure assets to provide the best environmental, economic, and social value to communities (FCM, 2016b). Eligible LAMP projects must focus on one of five priority areas: 1) asset management policy 2) strategy, and governance 3) levels of service 4) risk assessment, and/or 5) life cycle management. Projects that receive funding can access up to $175,000 (FCM, 2016b, n.p.). Among the 12 municipal recipients, one is located in NS. The Municipality of the County of Kings has received $32,500 to develop a more formal asset management policy and approach (FCM, 2016c, n.p.). By receiving this funding, this municipality will achieve asset management goals sooner, and become an asset management leader in NS (FCM, 2016c).

Small Community Infrastructure Fund:

The Small Community Infrastructure Fund (SCIF) is a funding agreement between the province of NS and the federal government as part of the 2014-2024 New Building Canada Fund. The SCIF is administered by the Department of Municipal Affairs. This funding will provide up to $42.6 million of federal funding for capital

infrastructure projects that will be matched by the province and municipalities (UNSM, n.d.b., n.p). NS municipalities and villages with less than 100,000 residents are eligible for the SCIF and eligible projects include wastewater, drinking water, solid waste management, disaster mitigation, connectivity and broadband, innovation, green energy, public transit, brownfield redevelopment, local and regional airports, short line railways, short sea shipping, highways, and major roads (UNSM, n.d.b).

2.3.2 Frameworks and Rating Systems

Envision:

Municipalities may choose to apply the Envision framework and tools during development. Envision was developed as a tool to help evaluate civil infrastructure for overall sustainability and includes a checklist, rating tool, credential program, project evaluation and verification program, and a recognition program for sustainable infrastructure (ISI, 2016). The checklist incorporates 60 criteria for sustainability principles and ensures users understand and consider appropriate options. The Envision assessment process also includes 60 criteria to measure improvement over a project's life (ISI, 2016). These assessments are meant to reward sustainability efforts and improve overall sustainable performance. Users can also use Envision to audit their infrastructure by using the same 60 criteria to determine where their project falls relative to similar projects in terms of sustainability (ISI, 2016). There are five attributes that make Envision unique and beneficial for municipalities to use during asset management and infrastructure renewal:

> *1) It can be applied to civil infrastructure;*
> *2) It t can be used during the design, planning, construction and maintenance phases;*
> *3) It is applicable during any time of the project's life;*
> *4) It considers the social, economic, and environmental infrastructure and product goals; and*
> *5) It can help municipalities keep pace with the ever changing notion of sustainability (ISI, 2016, p. 7).*

Envision can be used to rate energy, water, waste, transportation, landscape, and information infrastructure projects (ISI, 2016). During the rating, Envision incorporates questions about the project that pertain to the quality of life it provides, leadership, resource allocation, the natural world, and climate and risk factors (ISI, 2016).

Leadership in Energy and Environmental Design:

Similar to the Envision framework, Leadership in Energy and Environmental Design (LEED) is a rating system that offers sustainability evaluations through a certification program. The LEED certification program provides third party certification that a home, building, or community has high performance in areas of environmental health focusing on sustainable site development, water savings, energy efficiency, material selection, and indoor environmental quality (Canada Green Building Council, 2016). There are four certification levels in LEED (certified, silver, gold, and platinum) to provide flexibility and to accommodate various green building strategies.

In the 2009, the NS Climate Change Action Plan, goals have been set out for all new provincial government-owned buildings to achieve at least a Silver certification after 2008, a gold certification by 2010, and to be carbon neutral by 2020 (NS Environment, 2009). NS Environment (2009) also stated that Green Building Rating Systems are a widely used standard for sustainable construction. Furthermore, any organization that is seeking government funding for building projects must also acquire silver certification for energy efficiency and water consumption.

Electronic Product Environmental Assessment Tool (EPEAT):

In the realm of sustainable procurement, municipalities can also choose to purchase electronic office supplies from companies that are registered with EPEAT. EPEAT provides a rating for products based on sustainability. This rating also allows buyers to choose specific attributes that are more important to them such as reduced toxic material, the ability to recycle the product, and the amount of recycled material used (Green Electronics Council, 2016). Companies will register their product with EPEAT where it will be assessed based on criteria over the product's entire lifespan. There are Bronze, Silver, and Gold-rated products where Bronze meets all criteria, Silver meets all plus 50% of optional criteria, and Gold meets all and 75% of optional criteria (Green Electronics Council, 2016).

Lean Six Sigma:

Similar to the EPEAT certification, Lean Six Sigma is mainly implemented at the manufacturing stages of product creation. The mission of Lean Six Sigma is to reduce factory defects to 3.4 per million, which in turn reduces waste from defective products and allows for a more efficient manufacturing process (Guarraia et al., 2008, n.p.). The Lean Six Sigma certification will allow individuals to accredit companies that meet Six Sigma manufacturing standards (Guarraia et al., 2008). Municipalities could use this certification to make better product purchasing decisions by knowing which companies are reducing their waste and improving quality through the reduction of defects.

2.3.3 Sustainable Procurement

Municipalities could contribute to sustainability principles by adopting sustainable procurement practices. Sustainable procurement is “a holistic approach to government procurement that considers the environmental, economic and social factors related to the goods, services and construction that are procured" (Government of NS, n.d., p.4). Sustainable procurement allows municipalities to expand priorities from price, quality, and service to also consider the environmental and socio-economic impacts of a product (Reeve Consulting, 2012). Not only will municipalities be procuring more sustainable products, but sustainable procurement also includes working with suppliers to improve the environmental performance from the date of manufacturing to, eventual, disposal. Through sustainable procurement, municipalities can make product choices that have lower packaging, material use, GHG emissions, and toxins. Furthermore, through ethical purchasing, municipalities can avoid products manufactured by sweatshop labour to ensure fair labour practices (Reeve Consulting, 2012). Reeve Consulting (2012, p.3) calls sustainable procurement the $10 billion opportunity and in NS the province buys

over $800 million in goods and services every year, which does not include municipalities, agencies, schools, and hospitals, but illustrates a huge opportunity (Nova Scotia Environment, 2009, p. 25). Municipalities spend enormous amounts on goods and services and have a real opportunity to make change towards a more sustainable procurement market.

The Municipal Collaboration for Sustainable Procurement (MCSP) includes a group of 20 Canadian municipalities that aim to share resources and best practices for municipalities interested in adopting sustainable procurement practices (Reeve Consulting, 2012). When completed properly, sustainable and ethical procurement can have many benefits including: branding municipalities as leaders in sustainability by contributing to zero waste, reducing climate change, increasing local food consumption, achieving green economy goals, reducing municipal operating costs by purchasing more durable products that use less energy, building social capital, enhancing the local economy, and enhancing staff engagement by empowering them to make better choices (e.g. fair trade coffee, green office supplies) (Reeve Consulting, 2012, p.4).

Although there are not enough municipalities participating in these practices, sustainable procurement provides many benefits. In Canada, only two municipalities (City of Edmonton and City of Vancouver) report having a significant portion of a staff member's job dedicated to sustainable procurement. Inadequate resourcing presents a major obstacle for municipalities to implement these procurement practices. Reeve Consulting (2012) outlines a framework of 10 best practices to help municipalities reach sustainable procurement goals (p. 6):

1) *Having a strategy and action plan*
2) *Approving a sustainable procurement policy*
3) *Committing to triple-bottom-line sustainable procurement*
4) *Applying a supplier code of conduct with fair labour requirements*
5) *Deploying adequate program resources*
6) *Embedding procedures and tools into operating practices*
7) *Training staff and building capacity*
8) *Engaging with suppliers to stimulate innovation*
9) *Verifying performance*
10) *Collaboration*

It is important for municipalities in NS adopt sustainable procurement practices as they begin to phase out ageing infrastructure, systems, and office supplies, NS could become a sustainable leader. NS Environment (2009) stated that a broader sustainable procurement policy was being developed for the province and that all new information and communications equipment that is bought or leased for provincial offices must have a silver certification from the EPEAT.

2.4 Climate Change

In 2013, the Intergovernmental Panel on Climate Change (IPCC) released a report stating that human activity is warming the planet and will lead to increased temperatures, rising sea level, and more frequent storms (IPCC, 2013). NS has 13,300 km of coastline with 70% of the population residing along the coast, 14% of jobs in the coastal or ocean

sector, and a significant proportion of new development along the coast (Province of NS, 2011, p. 6). As a result of climate change and projected sea-level rise, coastal communities are vulnerable to erosion, storm surges, and flooding.

Climate change brings uncertainty with the potential for a negative impact on NS infrastructure. As asset management continues to grow in the province to provide reliable service delivery, asset managers must consider climate change during development. Silvent and Charrier (2015) state that one of the most direct and significant approaches to adapting and mitigating climate change is to invest in infrastructure that can transition to a low-carbon, resource efficient economy. Furthermore, as a significant portion of infrastructure is located along the coast in NS, asset management must consider the vulnerability of these assets to rising sea levels, coastal erosion, and increased flood risk (DeRomilly and deRomilly Ltd. et al., 2005).

The Adapting to Climate Change in Nova Scotia Report outlines multiple risks for communities and their infrastructure and transportation (DeRomilly and deRomilly Ltd. et al., 2005). This report highlights five high-risk, three medium-risk, and two low-risk areas among communities, infrastructure, and transportation that are vulnerable to climate change. Among the high-risk categories are: insurance and property values, transportation infrastructure, settlement patterns, port operations, changes to buildings and building code requirements (DeRomilley and deRomilley Ltd. et al., 2005).

To be proactive, it is suggested that municipalities take inventory and create vulnerability maps of communities, infrastructure, and buildings that are at risk due to climate change (DeRomilley and deRomilley Ltd. et al., 2005). The inventory and vulnerability map were likely already created from the information gathered during the development of MCCAPs from the mandatory piece of information under Step Four: Facilities and Infrastructure. Municipalities had to describe how facilities and infrastructure were vulnerable to climate change. A map of key infrastructure and vulnerable areas could then be overlaid to create a vulnerability map for municipal infrastructure (Province of NS, 2011). This vulnerability map in combination with the asset management inventory and location can identify more municipal infrastructure that may be at risk, which will prepare municipalities to make more informed maintenance decisions.

3.0 Methods

Information on sustainable asset management and infrastructure development was collected through the following three data collection tools: interviews, literature review, and case studies. Interviews are a useful qualitative method, which enables the collection of valid data under a time constraint (Creswell, 2014). Due to time constraints of the project, only a few interviewees were conducted resulting in limited qualitative data. In order to mediate this limitation, a literature review on sustainable asset management and a case study review of both positive and negative examples of asset management plans and infrastructure development were conducted. Both review methods are appropriate tools for data collection under financial and time constraints because data is publicly available and easily accessed on the internet (Creswell, 2014).

3.1 Interviews

Six industry experts were purposively selected for interviews based on UNSM's recommendations. The interviews with these key experts were conducted to collect information regarding the progress of municipal sustainability as well as the benefits, challenges, and potential opportunities of adopting sustainable asset management planning for municipalities. The interviews were conducted individually and audio-recorded. Each took between 40 and 70 minutes. These audio records were transcribed into text for data analysis. Please see Appendix B for interview questions.

Nvivo was used for data analysis of the interview transcripts to perform both inductive and deductive coding methods. According to Thomas (2006), an inductive approach for analysis of qualitative data helps condense raw textual data into a summary format and a deductive approach helps to categorize data based on the identified framework or codes. A combination of the two types of coding was used for the data analysis of the interview transcripts because it produced more reliable and valid findings. Specifically, inductive coding methods were used to identify the emerging themes in the transcripts. Subsequently, deductive coding methods were used to categorize the emerging themes identified in the interview transcripts. Finally, a thematic framework was generated based on the emerging themes to address the research questions.

3.2 Literature Review and Case Studies

The appropriate literature and case study ideas were gathered from government websites, white papers, scientific articles, newsletters, and/or recommended by UNSM. The information was searched for using key phrases including infrastructure asset management, sustainable asset management, municipal infrastructure, age of infrastructure, Canada's infrastructure, and sustainable infrastructure. If municipalities were identified for implementing sustainable practices during infrastructure management they were considered for case study review. Case studies were narrowed down to four to elaborate on the sustainable practices used and subsequent benefits acquired. Case studies were also considered for any consequences of not using sustainable asset management practices.

4.0 Environmental Analysis of Rural Nova Scotia Municipalities

Before conducting an analysis of asset management in NS, an external analysis considering the political, economic, social, technological, and environmental forces (PESTE) that affect rural municipalities in NS was conducted, revealing forces that may limit the ability of municipalities to implement asset management allowing more feasible recommendations to result from this project.

While external forces vary based on geographic location, factors relating to provincial/federal governments and Aboriginal communities were found to have the greatest influence on municipalities. The provincial government dictates taxation authority, service delivery obligations, and funding opportunities. However, the new federal government's focus on climate change and infrastructure renewal has introduced new funding programs which could increase capacity within these municipalities and enable them to better utilize resources.

4.1 Economic

An assessment of economic trends in NS revealed that a shrinking labour market paired with slow economic growth are a fundamental threat to rural municipalities and could lead to increasing out-migration (Ivany et al., 2014). Success in the expansion and improvement of processing infrastructure related to NS's agri-food, aquaculture, and clean energy industries will be imperative to sustaining the rural economy (NSFA, n.d.; Province of NS, 2012). Increased awareness and proper investment into research and development initiatives for these industries will help municipalities to benefit from their own valuable natural resources and thrive economically (Ivany et al., 2014).

4.2 Environmental

Climate change–the strongest force acting upon municipalities–brings erosion, storm surges, and sea-level rise to coastal municipalities (IPCC, 2013). Alarmingly, coastal communities are where the majority of the province's population and municipal infrastructure currently resides (Province of NS, 2011). The province has witnessed the effects of climate change through species extinction, water shortages, contamination, and severe storms (Province of NS, 2015d; 2016; Stagg, 2016). To reduce projected effects, municipalities must act now to reduce GHG emissions and contribute to climate change mitigation and adaptation initiatives in order to protect these coastal communities.

In the medium-to-long-term, climate change is the most notable environmental factor affecting municipalities. In order to adapt, infrastructure planning needs a holistic approach, incorporating both sustainability and resiliency to lessen the threat of injury and damage from weather events, particularly in coastal municipalities. Reducing GHG emissions, with the intent of controlling sea-level rise and protecting communities, needs to become a core component in community planning and investment initiatives.

A persistent need for technologies capable of reducing energy demand and improving energy efficiencies was identified as a key factor negatively impacting municipalities in rural NS. In order to reduce GHG emissions, municipalities will have to integrate sustainable practices and implement new and innovative energy efficiency and conservation initiatives (Stantec, 2011). As climate change is further prioritized, municipalities are beginning to act on the implementation of sustainable practices. Programs such as the *Municipal Funding Agreement, FGTF*, and the *Environmental Goals and Sustainable Prosperity Act* (Province of NS, 2011; EGSPA, 2007) are aimed at supporting communities in their efforts to improve energy efficiency and reduce emissions.

4.3 Political

Intergovernmental relationships and recent municipal elections also affect service delivery and long term planning for municipalities. To offer necessary services, municipalities must consult with one another, the provincial/federal government, and Aboriginal communities, as they have a legislated "duty to consult" with Aboriginal communities in the region (Province of NS, 2015b, p. 6). Municipalities must also adapt to recent elections by focusing on transitioning new officials rather than service delivery and long-term planning (Laroche, 2016). Not all political factors identified influence rural municipalities equally due to geographical location and organizational structure of

offices. The influencing factors are often related to the provincial government, federal government, other municipalities or other governing bodies.

4.4 Socio-Political

These rural communities, defined as having populations under 1000 people, make up 43% of NS's population (Gibson et al., 2015, n.p.). In recent years, three demographic social shifts have occurred: rural residents becoming urbanites, an aging population, and an overall decrease in population. Rural municipalities in NS are suffering from slow economic growth and a shrinking labour market (Ivany et al., 2014). These economic challenges magnify population threats through increased youth out-migration with reports showing that this decline would have a greater negative impact on rural communities than urban ones (Ivany et al., 2014). Changes must occur in order for rural municipalities to sustain their economy.

To realize such improvements, rural municipalities must adjust to challenges and opportunities within their national, provincial, and regional communities in order to provide services to citizens. Historically, municipalities are most affected by changes within the provincial context, as roles and responsibilities are governed by the *Municipal Government Act*, providing taxation authority and service delivery obligations (*Municipal Government Act, 1998*; Province of NS, 2013). The provincial government also provides financial opportunities by administering funds like equalization grants and the *FGTF*, which may or may not have attached directives (Government of Canada, 2014; Province of NS, 2015a). While the new federal government is further removed from the immediate context of municipalities, Budget 2016 introduced funding opportunities focused on climate change and infrastructure renewal, which stand to benefit municipalities and their planning initiatives (Government of Canada, 2016). Rural municipalities are also adapting to regulations on environmental standards putting further strain on their financial and human capital (Province of NS, 2013).

4.5 Technological

It has been concluded that climate change will affect the natural resources of these regions that provide food and financial stability to municipalities (Statistics Canada, 2016). The success of agri-food and aquaculture industries, which thrive off many of the province's natural resources, can promote rural economies (NSFA & NSDA, 2010; Province of NS, 2012). However, the potential of both industries have not been fully exploited due to the lack of processing infrastructure (NSFA & NSDA, 2010; Province of NS, 2012). Technology is a leading driver of change and rural areas are often disadvantaged by the inaccessibility of information and affordability of innovative technologies. For municipalities attempting to increase economic activity and productivity, sustainable initiatives are often forgotten when focusing on key drivers. For NS's rural municipalities, in order to flourish economically and take advantage of the province's key inputs, a sustainability focused strategy centered around agri-good, aquaculture, and clean energy will be imperative for success moving forward (Nova Scotia Business Inc., 2016).

4.6 Overall

Though climate change is a threat, it provides opportunities for municipalities to adapt. If done correctly, this adaptation will lead to resilient infrastructure to withstand storms reducing damage costs and injury. The pressure to reduce GHG emissions will integrate innovative technologies facilitating a more efficient use of energy and a conservation of resources for future generations. International investments into export-focused resource sectors also promote rural economies (Province of NS, 2012). Traditional Nova Scotian industries and new markets that they can enter (through globalization), provide economic hope for communities through a focus on attracting and retaining youth, and growing the economy with newcomers (Canadians, international immigrants). If proper investment into the province's research and development initiatives for new technology can be realized, job opportunity and productivity will rise for rural municipalities (Ivany et al., 2014).

Climate change poses a threat to rural and coastal municipalities that must adapt to rising sea-levels. Building more resilient infrastructure results in less capital short-term, but saves on storm recovery expenditures in the future. Budgetary constraints among government levels limit investments into quality infrastructure and services in rural areas. This threat becomes an opportunity through a renewed federal government focus on building communities—a shift for a strong entrepreneurial focus of rural NS. Social enterprises highlight the need for positive environmental change, while regional development authorities help diversify rural economies. Municipalities must adapt to threats of smaller labour markets forcing urban migration. Barriers limiting technological uptake in rural communities need to be addressed, as it is imperative to utilize growing information and clean technologies.

5.0 Making a Case for Sustainable Asset Management

This section presents the interview findings supported and supplemented with literature, to demonstrate: 1) benefits of developing a sustainable asset management plan for municipalities; 2) challenges of adopting such a plan in municipalities; 3) current sustainable practices identified in case studies; and 4) consequences of mismanagement.

5.1 Overview of Benefits

The FCM describes municipalities as the engine of the Canadian economy where the most promising solutions to achieve a green economy reside (Thompson & Joseph, 2011). As municipalities are the closest to individual citizens, greener policies are more feasible and benefits can be visually realized. Municipalities have control over 44% of national GHG emissions with most those emissions associated with infrastructure (Stantec, 2011, p. 3). Implementing sustainable asset management and incorporating energy efficiency, water conservation, and climate change concerns during renewable and retrofitting can accrue many economic, social, and environmental benefits for municipalities.

5.1.1 Economic

Currently in NS, excluding Halifax, economic growth has slowed and annual growth of Gross Domestic Product (GDP) hovers around 1% (Province of NS & UNSM, 2013, p. ii). The costs of municipal service delivery are escalating at 5% per year, which

is faster than both population and economic growth (Province of NS & UNSM, 2013, p. ii). For example, in 2009-2010, municipal expenditures were $1.2 billion providing financial obstacles for many municipalities (Province of NS, UNSM, 2013, p. 16). There are many competing priorities for municipal funding demonstrating why inadequate reinvestment in infrastructure occurs. Implementing sustainable asset management will help NS municipalities to provide more reliable service delivery while saving on municipal operating costs and making the delivery process more efficient.

At a micro-level, a good asset management plan can help to make assets cost-effective because municipalities can manage their costs at all stages of planning, operating, and disposing of infrastructure assets from a holistic perspective. If all assets can be replaced or maintained at an appropriate time, their entire life cycle costs will be lower than those not being appropriately treated. At a macro-level, a sustainable asset management plan will promote and support innovative infrastructure industries, which will then contribute to an increase in job creation and Gross Domestic Product (Interviewees, personal communication, October 2016).

Economic benefits are not always immediately visible in sustainable initiatives because they occur over time and are not seen in initial costs. For example:

- In 2004, the green building industry, an example of innovative infrastructure industries, created 300,000 direct jobs and almost $24 billion in GDP (Interviewees, personal communication, October 2016).
- The University of Alberta initially invested $80 million in energy efficiency and reduction measures, which saved over $320 million in longer term utility costs (Versteegc and Leblanc, 2016, n.p.).
- Atlanta, Georgia created a new staff position devoted to managing sustainability, which saved the city over $500,000 in the first year (Goldstein, 2011, p. 31).

Climate change is expected to increase the cost of maintaining infrastructure from $3.1 - $6.1 billion by 2080, depending on the intensity of climate changes (Larsen et al., 2008, p. 442). However, incorporating future climate vulnerabilities and costs such as increased flooding and coastal erosion into a sustainable asset management plan can save infrastructure costs by 10-45% by 2080 (Larsen et al., 2008, p. 454).

This literature suggests that to gain wide spread economic benefits from sustainability, municipalities must commit and ensure adequate resources are applied, and while this would require a higher upfront cost, the returns on investment will be significant and future savings can contribute to other sustainability initiatives or can support other municipal priorities. More efficient and sustainable services will ensure taxpayers' resources are being optimized and will build a stronger community.

NS has already been branded as an international leader in solid waste management, which has increased its financial and knowledge capacity in solid waste management allowing for the province's expertise to be shared (Province of NS, 2014b). Enhancing NS's sustainability leadership will improve the province's reputation and increase potential for economic development. Transitioning to cleaner energy sources and implementing energy efficiency will provide the province with more energy security while protecting against the rising cost of carbon-based fuel sources (Province of NS, 2014b). With the implementation of NS's Sustainable Procurement Policy in 2009, the

public sector spent over $2 billion in one year with over 75% going to local businesses providing a huge economic opportunity for the local economy (Province of NS, 2014b, p. 13). Furthermore, when municipalities make choices about the materials they purchase, this can drive sustainable market transformations by increasing the demand for sustainable products and decreasing the costs of sustainable products for the public (Reeve Consulting, 2012). Implementing sustainable practices will strengthen the NS economy by providing new education and employment opportunities while allowing municipalities to provide reliable, cost effective services.

Canadian Municipalities Benefiting from Sustainable Practices

A study on municipalities across Canada found that of 290 strategies to provide more cost-effective services, the most common strategy was implementing efficiencies pertaining purely to cost-containment (Whittaker, 2016). For example:

- Medicine Hat, Alberta and Brandon, Manitoba installed refilling station rather than stocking plastic water bottles.
- Victoria, British Columbia and Regina, Saskatchewan switched to a paperless system for property tax bills and payments.
- A number of municipalities have already replaced streetlights with LED bulbs, which will be mandated in NS by 2022. Replacing all municipal lighting from incandescent to LED will provide 75% energy savings and last 25% longer (U.S. Dept. of Energy, n.d., n.p.).
- Markham, Ontario, in partnership with the University of Waterloo, saved over $1 million annually by implemented sustainable road construction practices like integration of recycled products (Whittaker, 2016, pg. 3).
- Calgary saved $2.1 million per year by converting biogas to electricity instead of natural gas in three wastewater facilities, (Whittaker, 2016, pg. 3).

All of these changes have contributed to sustainable, cost-effective service delivery among municipalities.

By managing existing assets in the province, municipalities can assess when a building requires maintenance, retrofitting (incorporating sustainable infrastructure) or replacement. This efficient use of asset planning helps to reduce financial requirements in the long-term, by using existing infrastructure to its fullest extent, by recognizing both when the asset can be optimized or when the asset requires a replacement all-together. Through the incorporation of a sustainable asset management planning, municipalities can employ a holistic approach in a renewed strategy that focuses on reducing capital requirements. Having an inventory of assets, and the state of their conditions, can help municipalities be proactive in required upgrades, rather than reacting to damages caused by the effects of climate change. If left unmanaged, costs can quickly run high as there is no coordination on renewal efforts. Through proper management of assets, there is a logical decision-making model on which assets need to be fixed or replaced. This assures that municipalities will be able to resume their desired level of service delivery in the most cost-effective manner possible (Foster, 2015).

5.1.2 Social

As society becomes more aware of pressing environmental issues such as climate change, it is becoming less acceptable to be wasteful requiring the implementation of sustainable practices and energy efficiency. Furthermore, in many jurisdictions, it has become law, as evident in NS's Environmental Goals and Sustainable Priorities Act to reduce emissions and produce cleaner energy. For this reason, municipalities have a social responsibility to implement sustainable measures to demonstrate their commitment to contribute to global climate issues (Stapledon, 2012). Municipalities that implement sustainable asset management and infrastructure development demonstrate their commitment to becoming sustainability leaders, which can bring a positive image and reputation to the community (Fombrun, 2001). Organizations that take steps to reduce their environmental impact often receive recognition increasing their success by sharing the same values as their stakeholders.

NS municipalities have developed ICSP's that reflect the values of many of the people who live and work in these areas (UNSM & Golder Associates, 2013). When municipalities engage in sustainable asset management to upgrade technologies and reduce energy demand, they improve service function and reliability while meeting goals set out in municipal ICSP's. From these upgrades, societies benefit from an improved quality of life, a healthier environment, and cleaner drinking and recreational waters (World Green Building Council, 2014).

By encouraging health and wellbeing through reductions in waste and energy use, sustainability can encourage productivity (World Green Building Council, 2014). Therefore, people become more motivated and productive when given a healthy and safe work environment provided by sustainable building practices (e.g. better air and lighting quality). For example, using passive solar designs are a way to provide comfortable temperatures in office space while providing access to daylight. Furthermore, the implementation of green space within communities and organizations is beneficial for mental health through an instinctive bond to nature (World Green Building Council, 2014).

Implementing sustainable asset management will ensure that municipal infrastructure provides reliable services for future generations. By reducing emissions and stabilizing coastal infrastructure to mitigate and adapt to future climate change risks and events, municipalities can ensure that Nova Scotians maintain their close connection to the coast by ensuring a sense of safety within the community.

5.1.3 Environmental

Since Canadian municipalities contribute 44% of GHG emissions (Stantec, 2011, p. 3), updating infrastructure with new material and technology can reduce the environmental impact and emissions associated with service delivery. Implementing sustainable asset management will ensure infrastructure materials and municipal operations reduce waste and energy demand contributing to provincial environmental goals.

A sustainable asset management plan will help reduce GHG emissions mediating the influence of climate change, especially in some sensitive habitats that are vulnerable to adverse climate. A lot of NS infrastructure is in vulnerable areas, which makes it vital

to consider adopting a sustainable asset management plan based on environmental considerations. Furthermore, infrastructure is closely related to the quality of the natural environment because of its consumption of energy and water as well as the generation of solid waste and GHG emissions (personal communication, interviews, 2016).

Making municipal utilities and buildings more sustainable can reduce energy demand and subsequent emissions. For example, alternatives to water treatment facilities can reduce 30% of energy demand through improving existing pumping systems, up to 50% for implementing aerobic sewage treatment, 20% for updating drinking water processes, and 15% for improving building services (WERF, 2010, p.g. xiii). For example, in Mount Pearl, Newfoundland, the community witnessed high water consumption rates until the city created a program to detect leaks in the water pipes. Due to this innovative technology, crews spend detecting the leaks allowing resources to be spent elsewhere and maintaining this infrastructure more effectively. In the city, water consumption was reduced by 25% and more reliable services were provided (Whittaker, 2016, p. 9). The implementation of water and energy conservation initiatives will ensure these resources are secure for future service delivery needs while providing a cleaner environment in the present.

Furthermore, sustainable asset management can manage climate change risks and improve the resiliency of infrastructure to future storm predictions. As mentioned above, the MCCAPs map out areas with vulnerable municipal assets, which can be paired with asset management to enhance municipalities adaptive capacity to mitigate climate change risk by ensuring proper investments are made to the most vulnerable assets (Province of NS, 2011). In the United States, a lack of formal asset management planning is the primary reason that infrastructure engineers and planners do not have sufficient information to attain climate change adaptation goals (Neumann, 2009).

With the proactive nature of a sustainable asset management planning, it can also be considered as a decision-making tool. A good asset management plan can provide decision-makers with valuable information about assets so that they can manage assets in a more effective and efficient way, thereby achieving sustainability goals (personal communication, interviews, 2016).

In general, municipalities that prioritize the designing and building of sustainable infrastructure have demonstrated benefits across various areas. By building sustainable infrastructure, municipalities can gain benefits related to the environment such as, energy efficiency, which reduces overall energy requirements. Financially, energy efficiency translates into obvious economic benefits, such as an overall cost reduction on powering efficient buildings and other assets. Socially, many citizens wish to live in healthy and productive communities while respecting the needs of future generations. While people and municipalities may cite different reasons as to why they are unable to lead sustainable lifestyles, the benefits far outweigh the costs in the long-run–the challenge is to increase buy-in of this increasingly apparent pattern. This is a laudable goal, which requires an open mind, patience and understanding. The latter is paramount, because the current discourse surrounding sustainability is that it is the antithesis of economic prosperity. The truth is that this is a contradiction to the very essence of sustainability, which is to make decisions that will be productive in the present while respecting the needs of the future.

5.2 Overview of Challenges

The challenges discussed by interviewees can be categorized into four types: 1) management; 2) decision-making processes; 3) motivation; and 4) capacity, which are elaborated respectively in the following section.

5.2.1 Management

Interview results suggested that municipalities face a few aspects in implementing sustainable asset management plans:

1. Municipalities are currently managing and organizing their assets by class, placing accountability on specific departments, which creates inefficiencies in a system that should consider a holistic and coordinated view of the long-term life cycle of assets.
2. Boundary spanning is necessary for sustainable asset management because municipalities must improve their asset management through an understanding of opportunities and challenges by collaborating with internal stakeholders from diverse departments. For example, within a municipality there are boundaries between departments (e.g., Mayor's office and Public Works) that are difficult to bridge through productive communication.
3. Accountability issues could be a result of a lack of communication, especially in smaller municipalities with fewer employees and departments, because it is difficult to have clear responsibility distribution.
4. The visibility of assets can result in visible assets being replaced regularly while less visible assets are neglected.

5.2.2 Decision-making processes

Sustainable asset management planning is continuously challenged in municipalities by the needs for both economic development and environmental protection. It is necessary to find a balance between these two needs allowing both to be achieved simultaneously. For example, municipalities should consider implementing procurement policies that champion both of these needs. Innovative and progressive procurement policies will increase the choices municipalities can make surrounding the procurement of sustainable and effective goods. However, often elected officials lack the will to create innovative infrastructure policies due to the long life cycle of assets and the short election cycle, a reinvention of procurement policies.

5.2.3 Motivation

Without an understanding of the importance of sustainable asset management planning, municipalities may lose motivation to address infrastructure concerns. Generally, citizens are not aware of the importance of investment in the infrastructure planning process and are not aware of long-term benefits. This lack of knowledge could be addressed if there were champions of asset management planning at the political level. However, elected officials may not have the knowledge or interest in long-term asset management plans because it surpasses the short-term election cycle. Elected officials are often very concerned about the economy in their region due to its immediate and obvious impact on their citizens while the environment seems less pressing in the short-term.

Often the lack of knowledge and motivation is due to the jargon that accompanies sustainability planning including asset management planning, integrated community sustainability planning, climate change adaptation, and sustainable development. These types of terms sometimes encourage the disengagement of citizens and elected officials who do not have the specialized knowledge.

5.2.4 Capacity

The challenges of adopting a sustainable asset management plan can also be caused by insufficient resource capacities (personal communication, interviews, 2016). Some municipalities, especially those with smaller scales, do not have enough financial budget and human resources to developing asset management (personal communication, interviews, 2016). In addition, municipalities have difficulties to retain qualified and experienced people in jobs that require sustainability-related knowledge and expertise. This is partially attributed to a lack of systematic staff training, education, and succession planning in many municipalities (personal communication, interviews, 2016).

5.3 Case studies

5.3.1 Positive Examples

City of Hamilton, Ontario – Asset Management Plan

The City of Hamilton, Ontario had a population of 519,949 in the 2011 census (Statistics Canada, 2011a, n.p). Under Ontario's Municipal Infrastructure Investment Initiatives, municipalities are required to submit a detailed Asset Management Plan (City of Hamilton, 2014). The City of Hamilton has created a plan for its Public Works. The plan will be revisited over a five-year cycle in order to ensure consistency with other report updates (City of Hamilton, 2014). The plan consists of a State of Local Infrastructure with the State of the Infrastructure (SOTI) scores for water, wastewater, stormwater, and road and bridges, which includes ratings and trends for each type (City of Hamilton, 2014). Hamilton has moved to adopt a service-focused view of its infrastructure and investments allowing it to measure, target, and weigh investments based on service impact and risk establishing a clear relationship between infrastructure investments and service outcomes (City of Hamilton, 2014). A Level of Service Framework was established around dimensions such as accessibility, safety, reliability, regulations, and customer service (City of Hamilton, 2014). The Plan also considers climate change, aging infrastructure, active transportation, underfunded transportation network, uncertainties in growth forecasts, declines in water consumption, socio-political expectations, and shifts in funding priorities as known Level of Service influencers (City of Hamilton, 2014). The Asset Management Strategy itself highlights major tools and practices that the City can utilize such as inventories, performance assessment, performance forecasting, demand planning, risk assessment, options analysis, coordinated decision making, investment planning, and life cycle management (City of Hamilton, 2014). The plan provides comprehensive options and tools for the City to manage is various infrastructure investments through a forward-looking framework.

Cornwall, Ontario – Canal Bridge

The cross-border Canal Bridge in Cornwall, Ontario (population 46,340) (Statistics Canada, 2011b, n.p) is expected to require significantly less maintenance than most of the other 80,000 bridges across the country. The bridge is built from a new class of concrete, which should allow it to stand the effects of harsh weather, heavy traffic, road salt, and acid rain (National Research Council, 2015). Bridge decks built from traditional concrete can generally last up to 25 years before needing significant repairs or replacements, but this new concrete developed by the National Research Council can last up to 100 years before requiring major repairs under the same conditions (National Research Council, 2015). This project was implemented with the expertise of various public and private partners Transports Québec, the National Capital Commission and the City of Ottawa, as well as W.R. Grace, Lafarge North America and Northeast Solite (National Research Council, 2015). The NRCC concrete formulation will come in at a considerably lesser cost over its life cycle than other high-performance concrete (National Research Council, 2015). This project demonstrates a partnership between government, scientists, and industry to develop infrastructure technologies that will be more environmentally and financially sustainable.

Markham, Ontario – Solid Waste Management Strategy

Markham, Ontario had a plan to decrease the waste being sent to landfills by 80%, but surpassed this goal by decreasing its waste by 81% (Persico, 2013, n.p.). The following regulations and activities were put into place for Markham to achieve its goal (Town of Markham, 2012, p. 2):

1. *Mandatory Material Separation By-law*
2. *Unlimited Clear Bags for Residue*
3. *Expanded Textile/Carpet Diversion Program*
4. *Zero Waste for Schools Program*
5. *Establish Retail Bag Policy for Markham*
6. *Enhanced Promotion & Education*
7. *Reuse Depot for Renovation Materials*
8. *Curbside Electronics and Battery Collection Ban*
9. *Establish Spring & Fall clean-up days*
10. *Expanded Fall Leaf/Yard Waste Collection*

The various regulations and activities have different elements and funding attached to them such as a promotion and education component, which includes an annual environmental awareness day and social media/marketing tools (Town of Markham, 2012). Markham's project will have a three-year implementation cycle for the components and some of the subcomponents (Town of Markham, 2012).

Municipality of the District of Shelburne, NS – Sewage Treatment Plant Upgrade

A protocol developed by Engineers Canada's Public Infrastructure Engineering Vulnerability Committee (PIEVC) was used to assess the "vulnerability of the Sandy Point Sewage Treatment Plant Upgrade to the effects of climate change" due to the coastal area of the municipality (ABL Environmental Consultants, 2011, p. i). The effects of climate change on coastal regions include "increasing storm frequency and intensity, rising sea levels, storm surge, and coastal erosion and flooding", which can be adapted for with proper infrastructure preparations (ABL Environmental Consultants, 2011, p. i). This protocol addresses different issues regarding the vulnerability of infrastructure to adaptation needs:

"The PIEVC Protocol combines basic risk assessment procedures into a process that first identifies vulnerabilities in public infrastructure systems and then applies an engineering analysis methodology in order to recommend mitigation measures to address the identified vulnerabilities. The vulnerabilities are defined as a combination of a climate event and its potential impact on a system component. The likelihood and consequence of the climate event and the system impact are considered, in order to determine the risk and whether mitigating action is required" (ABL Environmental Consultants, 2011, p. i).

The use of the protocol to analyze the sewage treatment plant resulted in a risk assessment being conducted where there was found to be 122 high and medium risks (ABL Environmental Consultants, 2011, p. i-ii). An engineering analysis of these risks was conducted, where the following recommendations were made through expert judgement (ABL Environmental Consultants, 2011, p. iii):

- *Reduce inflow and infiltration (I&I) into the collection system*
- *Install backup power supplies at the pumping stations*
- *Ensure the process building meets code for hurricane resistance*
- *Install a radio communications system at the pumping stations and process building*
- *Install high level pump shutoffs at the existing pumping station*
- *Install a bypass on the grit removal system*
- *Implement a policy to protect staff from hurricanes, storm surges and ice storms Discuss safe conditions for deliveries from septage hauling companies*
- *Adjust scheduling to accommodate required maintenance*

5.3.2 Consequences of Mismanagement

Not utilizing sustainable and thorough asset planning and management practices could result in assets not fulfilling the level of service or life cycle that is expected for them. An asset not fulfilling its purpose could decay more quickly than planned for, but it could also happen suddenly plunging a community into an emergency situation. For

example, the newly constructed Nipigon River Bridge in Nipigon, Ontario (population 1,631) (Statistics Canada, 2011c, n.p) heaved apart, which indefinitely closed the Trans-Canada highway on the only road connecting Eastern and Western Canada forcing travelers to go through the United States (Husser, 2016). Greenstone, a community northeast of Nipigon, had to declare a state of emergency because of the road closure (Husser, 2016). An independent engineering review of the incident found that the design of the shoe plate and its flexibility, a lack of rotation in the bearing that was constructed, and improperly tightened bolts attaching the girder to the shoe plate produced the malfunction (Province of Ontario, 2016). The findings suggest that neither climate nor weather created this malfunction, but rather a faulty infrastructure design. The bridge was the province's first cable-stayed bridge (Husser, 2016) suggesting that a more thorough analysis needed to be done to address potential issues that could lead to the bridge not fulfilling its purpose. The engineering firms involved in the construction of the bridge are now subject to a probe by Engineers Ontario, which could result in fines or losses of licenses if they are found at fault (Clutchey, 2016). This issue plunged communities and travelers into panic as they could not enter the Western portion of the country.

6.0 Discussion

The following discussion uses interview results to identify the current status of asset management plans in Canada and NS, potential forces that can drive the development of sustainable asset management planning, and considerations for planning and implementation.

6.1 The State of Asset Management Plans in Canada and NS

According to our interview results, asset management planning is a relatively new way to manage infrastructure in Canada with only approximately 25% of municipalities in Canada having adopted an asset management plan. Only a quarter of these plans cover the considerations of climate change and risk management. Most Canadian municipalities do not have a clear understanding of their biggest vulnerabilities, and the gap in this understanding results in a confusion about priorities, which must be addressed. The development of asset management plans is more advanced in larger cities, because of their resource capacity. Due partially to limited financial/human capacity and a rural location, most Nova Scotian municipalities are still learning about the need for asset management planning.

The status of asset management in NS is largely inconsistent across the province, with some municipalities making it a priority and others not (CIRC, 2016; D. Nielsen, personal communication, Sept 21, 2016). A major reason for this discrepancy may be related to the 4-year municipal cycle. Politicians who are concerned with becoming elected/re-elected may prioritize objectives that can have actionable and positive outcomes during their terms. For instance, a party/individual will be far more memorable to the public if there is new, tangible infrastructure built (i.e. a new community ice arena) during their term in office. However, new infrastructure may not always better. Rather, sustainable and cost-effective measures related to the maintenance and rehabilitation of existing infrastructure can help optimize the uses and outputs of existing assets. These assets have already had significant capital investments into their construction, which means that extending their lifetime should remain a priority, whenever possible.

6.2 Factors that Can Encourage Sustainable Asset Management Planning

According to our interview results, there are four factors stimulating municipalities to adopt sustainable asset management planning.

1. Public engagement has helped to promote and raise environmental awareness about the importance of sustainability. An increased public awareness in sustainability can draw elected officials' attention to sustainability issues (e.g., sustainable asset management planning).
2. Market forces from new innovative infrastructure industries have the potential to promote the development of sustainable asset management planning.
3. Governmental forces can also drive the development of sustainable asset management planning. For example, due to the adoption of Public Sector Accounting Boards (PSAB) 3150, municipalities must include the cost of their tangible capital assets on their financial statement and must show assets' depreciation over time. PSAB requirements require that municipalities consider and analyze the condition of their assets. In the past, elected officials were not required to show anything in regards to their assets on their financial statements to confirm their performance in asset management. For example, New Brunswick must include tangible asset costs in their financial statements to be in accordance with PSAB 3150, which demonstrates a government requirement to manage and account for assets.
4. Social forces from the public contribute to the promotion of asset management planning. The decisions of municipalities are open for the public to comment with municipalities being the closest to citizens due to its service delivery function. Municipalities are always trying to mitigate public pressure and ensure transparent decision-making, which means that public pressures surrounding certain issues can cause real change in municipal government actions.

6.3 Key Considerations for Adopting Sustainable Asset Management Plans

This subsection presents several key considerations and includes good practices for a sustainable asset management planning as identified from interviews. The examples of learning resources, and potential funding sources for municipalities are also provided in Appendix E.

Key Consideration #1

At the planning stage, it is important to have a clear understanding and recognition of the nature and benefits of a sustainable asset management plan. Developing a sustainable asset management plan is a learning process, and it is hard to obtain a one-size-fits-all solution. The success stories in big cities may be difficult to copy in a smaller community due to the difference in their conditions such as resource capacities. Different capacities and conditions of municipalities indicate that there are no identical cases in developing a sustainable asset management plan. There are many uncertainties during this development process, and due to the complicated nature of sustainable asset management planning, these uncertainties must be addressed by a number of different stakeholders. Cross-boundary collaboration is needed in order to

engage all necessary stakeholders. A clear understanding of the concepts of asset management planning and sustainability would be an asset in a cross-boundary collaboration process. Asset management planning may be a new term but not a new concept because it may be the way that stakeholders already manage their assets.

The creation and implementation of a sustainable asset management plan should include economic, environmental, and social considerations. Due to the different conceptualizations of terms, it is important for stakeholders to agree on various broad definitions to guide their collaboration. These issues are closely related to the understanding of an asset management plan in terms of its purpose and scope.

Key Consideration #2

It is essential to keep a holistic, strategic, innovative, big-picture view for developing a sustainable asset management plan. An asset management plan does not only include the planning for a new infrastructure, but also for managing existing infrastructure. Planning should encourage innovative infrastructure, but at the same time, should encourage innovations on how to reuse and reinvigorate existing infrastructure. Management strategies should be devised for all infrastructure regardless of the level of importance it has within the community. Linkages between different infrastructure should be clearly identified because these linkages will encourage a holistic perspective of planning and service delivery. For example, when a road or a network of roads are chosen considered, it is important to think about what services these roads provide in terms of their long-term benefits. If roads can be designed in an innovative way under the consideration of stormwater management, walkways or pedestrian infrastructure can then become multifunctional and can be better used to manage stormwater. Other associated issues with stormwater such as flooding may also be potentially addressed. Currently, municipalities are managing their assets by asset classes at an individual basis, rather than a more strategic, holistic way. If assets are considered individually, it would result in a difficulty of coordinating asset management work. For example, if water and sewer infrastructure work are not coordinated with road works, then workers would have to dig roads twice because water and sewer infrastructure can only be accessed by digging down the roads. Therefore, it is important to maintain a holistic perspective of asset management planning.

Key Consideration #3

Municipalities can start with creating an asset registry or inventory to understand and track the conditions of assets they have because this starting point will allow them to have a holistic understanding of their existing assets which will then help municipalities to determine their next step in an asset management plan. A good asset registry acts as a baseline for further life cycle cost analysis, and a foundation for a solid sustainable asset management plan. A measurement tool, such as Energy Star Portfolio Manager, would be helpful to track their assets for creating and updating such an asset registry. In addition, building a life cycle cost analysis of assets and/or infrastructure would be very helpful for deciding future asset management activities. With life cycle cost analysis, decision-makers will have a more holistic idea about their asset management plans rather than just focus on short-term insights about the costs of assets. Some assets may bring long-term benefits at the expense of short-term costs. Both long-term and short-term benefits and

costs associated with an asset should be considered in a decision-making process, and life cycle cost analysis will provide decision-makers with holistic insights for their assets. In addition, life cycle practices can help decision-makers to know how long an asset should be maintained and when this asset should be replaced.

Key Consideration #4

There are a few potential improvements in developing a sustainable asset management plan for municipalities to achieve. Many municipalities do not have specific sustainability officers to help develop a sustainable asset management plan, and it may be useful to create a network to allow sustainability officers in different municipalities to communicate and learn from each other by sharing their experience, which would be helpful to promote the development of sustainable asset management plans. Another participant also suggested the creation of a public platform that allows anyone with related expertise to share their experiences for mutual learning purposes. Another area of improvement is the important practice would be to incorporate risk management into infrastructure or asset management planning.

Key Consideration #5

Participants suggested a number of other practices related to life cycle management. Certain assets should be managed in "an average annual program" so that the level of work and costs required for the maintenance and renewal of the assets would remain consistent. Furthermore, policies, procedures, and standards can be created innovatively to manage assets and increase their life cycles. For example, in order to protect road infrastructure, truck drivers may not be allowed to go over a particular road during a particular time period of hot days. Regular inspection should be considered as a standard practice for the maintenance of assets and infrastructure. It is necessary that once an asset is built that it is maintained throughout its life. A new asset requires maintenance; therefore, it is necessary to plan regarding maintenance activities and inspections.

Key Consideration #6

Municipalities are encouraged to learn from each other, and there are a number of Canadian provinces and cities provided as good examples with advanced progress in developing sustainable asset management plans. British Columbia (BC) was most frequently mentioned by participants. As for municipalities or cities, participants listed: Calgary (AB), Halifax Water (NS), Fredericton (NB), Windsor (ON), Vancouver (BC), Ottawa (ON), and the Municipality of Kings (NS).

In addition to these case studies, there are a few organizations also listed as a potential learning resource for municipalities: the Canadian National Asset Managers (CNAM), Credit Valley Conservation Authority in Ontario, Asset Management BC, Copper Leaf Technologies, and FCM. Three tools are also suggested to explore for learning purposes: BC Climate Action Toolkit, Energy Star Portfolio Manager, and Envision.

Key Consideration #7

As for addressing cost and resource constraints, there are a number of available funding sources at the federal, provincial, and regional levels. Federally, the FGTF and Federal Infrastructure Funding are two examples. Regionally, the Energy Efficiency Conservation Fund is an example of a funding opportunity in Atlantic Canada. Provincially, there is a funding opportunity for small programs working on flood mitigation mentioned briefly by participants.

The financial shortage in municipal budgets, to some degree, can also be address by an increase in public education. Public education can help the public to understand what is needed for infrastructure and then this understanding would make them easy to accept a necessary increase in taxes or diversion of funds from another program to asset management. For example, in Saskatchewan, the tax rate was increased by 20% for years in order to address their wastewater infrastructure issues, and taxpayers understood that the repairs were necessary.

7.0 Recommendations

Recommendation #1

Sustainability can provide many economic, social, and environmental benefits for infrastructure. **Therefore, it is recommended that municipalities consider the use of sustainability tools and programs such as the Green Municipal and Small Community Infrastructure Funding opportunities, Envision, LEED, and EPEAT evaluation frameworks, and sustainable procurement policies**. These tools can facilitate municipalities to effectively implement sustainable asset management by helping them financially, providing assessments to determine the sustainable performance of infrastructure and identifying areas of improvement. Where improvements can be made to sustainable performance, procuring sustainable materials to make these improvements can extend the life of infrastructure assets.

Recommendation #2

In order to implement effective and long-term sustainable asset management plans and infrastructure, it is necessary for municipalities to garner support from their citizens. **Therefore, it is recommended that municipalities implement public education sessions and strategies to communicate the importance of sustainable asset management for responsible service delivery.** Public engagement could take place via town halls, social media campaigns, or ad campaigns. These strategies must vary based on geographic locations and regional demographics. For example, older communities may benefit more from town halls and ad campaigns while younger communities may benefit more from social media campaigns.

Recommendation #3

Every community will be implementing sustainable asset management differently based on current needs and perspectives, but these experiences can be useful for future planning. **Therefore, it is recommended UNSM construct a platform or method for municipalities to share sustainable infrastructure practices and lessons learned for other municipalities to learn from.** This type of platform will aid municipalities assess costs and benefits of implementing sustainable asset management practices through real-world examples here in NS. Furthermore, this platform will create a knowledge base among municipalities in different kinds of sustainable infrastructure practices, which will help municipalities looking to implement similar practices connect with those knowledgeable of the implications.

Recommendation #4

Climate change poses great risks to coastal infrastructure especially here in NS with ample coastlines and much of municipal infrastructure residing in these regions. It has been recommended to include climate change vulnerabilities and adaptations among asset management plans. **Therefore, it is further recommended that municipalities**

prioritize the adaptation, maintenance, and renewal of infrastructure assets that are vulnerable to changes in climate to reduce the risks of climate change damage.

8.0 Conclusions and Implementation Strategy

It is recommended that municipalities take a three-phased approach over 2 years in order to accomplish the requirements of the FGTF and create sustainable asset management plans that will support sustainable community development and growth. The below graphic demonstrates the steps that should be taken place between January 2017 and January 2019 with a sustainable asset management plan being implemented prior to the 2018 deadline.

Figure 1: Proposed Two-Year Asset Management Plan Implementation Strategy for NS Municipalities

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11.0 Appendices

11.1 Appendix A: Interview Guide

1. Can municipalities benefit from incorporating sustainability into their asset management planning?
   - If not, why do you say so? Why not?
   - If so, how so?

     Prompts:
     a. Economic, environmental, and social?
     b. Long-term benefits vs. short-term benefits?

2. What sorts of 'assets' do you think are most relevant when it comes to incorporating sustainability into their asset management planning? Why?
   - What sorts of 'infrastructure'?
   - Is there a difference between 'assets' and 'infrastructure' in this context?

3. Do you know of any communities with good sustainable asset management practices we could analyze as examples?

   Prompts:
   a. If so, which ones?
   b. Which plan (s) do you think is/are best? Why?
   c. Which components or parts of these plan (s) do you think is/are best? Why?

4. What are some common practices municipalities should be implementing when *maintaining* infrastructure to improve sustainability?

5. What are some common practices municipalities should be implementing when *renewing* infrastructure (to improve sustainability)?

6. Do you believe municipalities are progressing towards sustainable infrastructure?
   - Why or why not?

7. If not, what do you believe are reasons that some municipalities are not progressing towards sustainable asset management planning?

   Prompts:
   a. Is it a priority?
   b. Are they incorporating it into their strategic plans?

8. What types of sustainable infrastructure principles and/or practices would you recommend municipalities adopt as they maintain and renew assets?

Principles:	for maintaining assets	☐
	for renewing assets	☐
Practices:	for maintaining assets	☐
	for renewing assets	☐

9. Are there any new innovative infrastructure designs that municipalities could implement?
   - Wastewater, sidewalks, lighting, etc.?

10. What kinds of challenges do municipalities encounter when they try to incorporate sustainability principles into their asset management planning?
    - What are the factors that influence these challenges (rural, urban, geographic region)?
    - How can these challenges be overcome or addressed?

11. Do you know of any programs or incentives that municipalities can tap into for funding, expertise, or certification on creating sustainable asset management plans or sustainable infrastructure?
    - What frameworks exist to support sustainable asset management?
    - What opportunities exist that might be harnessed to support the development of sustainable infrastructure?

12. Do you have any additional comments/suggestions on this topic that have not been included in the previous questions?

11.2 Appendix B: Themes from Interview Results

Theme #1

Benefits for municipalities to adopt sustainable asset management plans (e.g., economic, environmental, and social; long-term and short-term)

- A decision-making tool
- Cost-effectiveness
- Economic benefits
- Environmental benefits
- Relationship between sustainability and asset management plans

Theme #2

Current status of asset management plans in Canada and NS

- Current status of Canadian asset management plans
- Current status of NS

Theme #3

Foreseeable challenges of adopting a sustainable asset management plans for municipalities

- Accountability issue
- Asset management deficiency
- Balance between the economy and environment
- Barriers of systematically valuing natural capitals
- Challenges of getting experienced people
- Confusion of different terms used
- Cost and resource constraints
- Cross-boundary collaboration issues
- Deferred maintenance
- Political barriers
- Lack of awareness of understanding the importance of planning process
- Need for education in some (small) municipalities
- Need for political will
- Need for sustainability officers within municipalities
- Need for theoretical guidelines

Theme #4

Possible solutions to cost challenges

- Possible solutions for the cost challenges
    - Public education

Theme #5

Factors stimulating the incorporation of sustainability into municipal asset management plans

- Community engagement
- Market and governmental forces
    - The example of PSAB 3150
- Social forces from the public

Theme #6

Considerations in incorporating sustainability into municipal asset management plans

- At the planning stage:
    - Conceptual: Clear understanding about the incorporation process
        - A learning process
        - A slow process
        - Full range of sustainability
        - Difference between assets and infrastructure
        - Need for cross-boundary collaboration
        - The understanding of asset management plans
    - Conceptual: Have a holistic, strategic, innovative, big-picture thinking of sustainable asset management plans
        - Linkages between different infrastructure
        - Innovative policies
        - Need for a big-picture thinking
    - Practical: Examples of the 'most relevant' infrastructure while considering sustainability into asset management plans:
        - There is no the most relevant infrastructure because all infrastructure should be incorporated with sustainability.
    - Practical: Examples of good practices
        - Average annual programs for particular assets
        - Case by case references
        - Energy management
        - Need for a measurement tool
        - Need for building in life cycle cost analysis
        - Need for good asset registry
        - Need for risk management
        - New innovative infrastructure designs
        - Need for sustainability officers within municipalities
        - Plans should be context-specific
        - Need for a public platform
    - Practical: Available learning resources
        - Programs/organizations
            - Future opportunities for case study analysis: There are a few organizations provided by the participants that can be

considered as a potential learning resource, e.g., the Canadian National Asset Managers (CNAM), Credit Valley Conservation Authority in Ontario, Asset Management BC, Copper Leaf Technologies, and FCM's website.

- Good examples of provinces or cities
    - Calgary
    - Good examples of cities
    - The leading role of BC
    - The leading role of Halifax Water in NS
    - Vancouver
- Other tied things
    - Climate change adaptation plan
    - Integrated community sustainability planning

- Practical: Available funding resources
    - Available provincial support
    - Available regional support
    - Available federal support
        - Federal gas tax funding
- Practical: Useful tools
    - Energy Star Portfolio Manager
    - Envision
- At the maintenance stage:
    - Considerations in maintaining infrastructure
    - Faulty thinking about sustainable assets
    - Need for regular inspection
- At the renewing/replacing stage:
    - Considerations in renewing/replacing assets
        - Making a certain percentage of available capital funding

11.3: Appendix C: Future Works - Tools & Resources for Asset Management Planning

Energy Star Portfolio Manager:
https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager

- Free energy benchmarking tool (mandatory in NY; much of Ontario uses it)

Canadian Network of Asset Managers
http://cnam.ca/

- Suggestion to connect with Executive Director to further primary research on AM

Credit Valley Conservation Authority
http://www.creditvalleyca.ca/

- Pioneering retrofitting of current infrastructure in Ontario

Ontario Good Roads Association
https://www.ogra.org/

- Infrastructure academy in Ontario

BC Climate Action Toolkit
http://toolkit.bc.ca/

- Integrated community sustainability plans, AM plans

UN Sustainable Development Goals
http://www.un.org/sustainabledevelopment/sustainable-development-goals/

- Focus on relevant ones from the 17 listed; including but not limited to:
    - 7. Affordable & Clean Energy
    - 9. Industry, Innovation & Infrastructure
    - 11. Sustainable Cities & Communities
    - 13. Climate Action

Global Affairs Canada
http://www.international.gc.ca/gac-amc/index.aspx?lang=eng

- Gives an international context within Canada

Infrastructure Canada
http://www.infrastructure.gc.ca/index-eng.html

M-45 Private Member's Bill - Andy Fillmore
https://www.youtube.com/watch?v=M1X-eVwfYy0

- M45 proposes greenhouse gas emissions analyses of government infrastructure
- Founder of CanU: *Council for Canadian Urbanism*