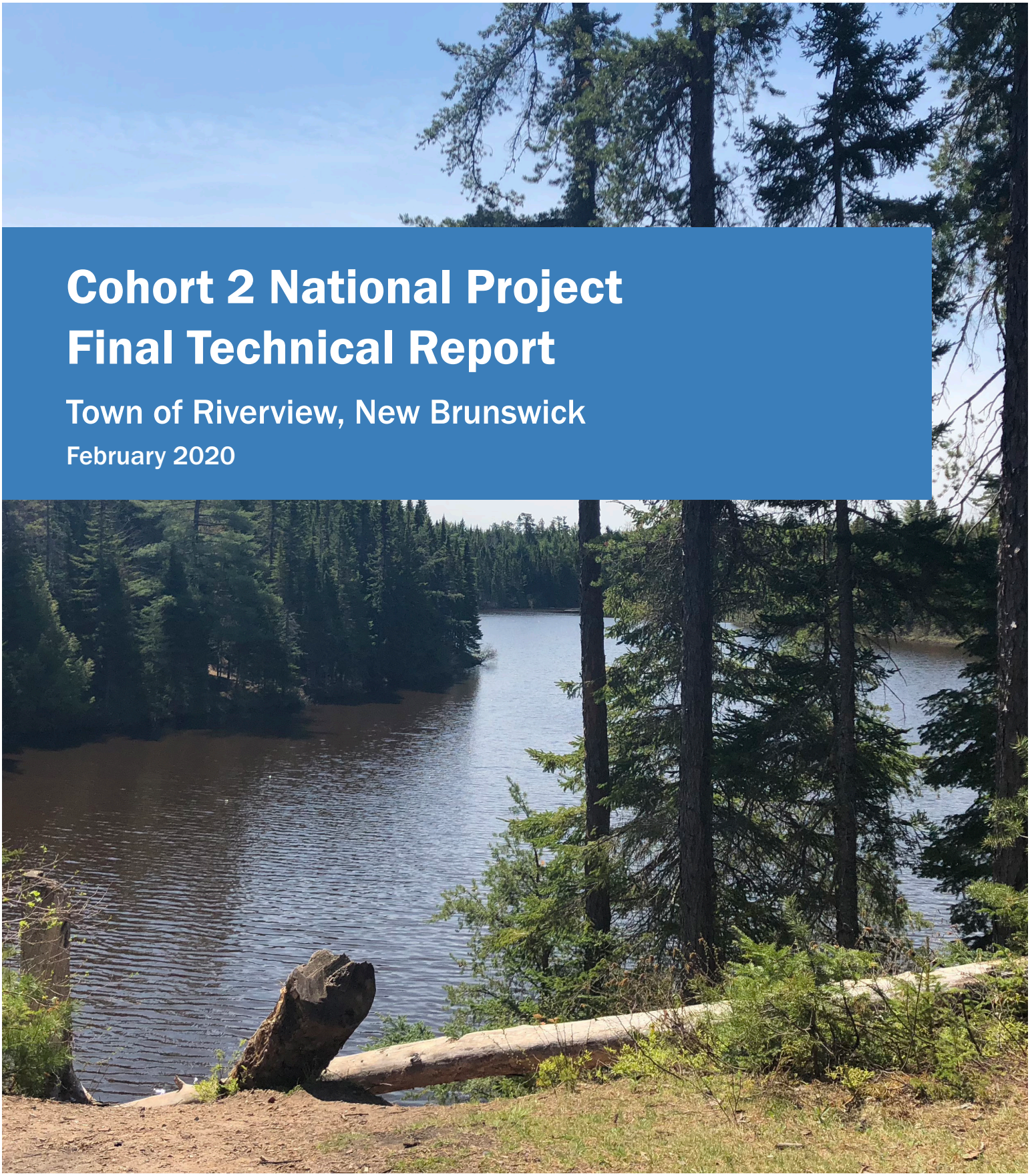

Cohort 2 National Project Final Technical Report

Town of Riverview, New Brunswick

February 2020

Municipal Natural Assets Initiative

Making Nature Count

INVEST IN NATURE

The Municipal Natural Assets Initiative (MNAI) is changing the way municipalities deliver everyday services, increasing the quality and resilience of infrastructure at lower costs and reduced risk. The MNAI team provides scientific, economic and municipal expertise to support and guide local governments in identifying, valuing and accounting for natural assets in their financial planning and asset management programs and developing leading-edge, sustainable and climate resilient infrastructure.

Acknowledgements

Technical report prepared by: MNAI Technical Team: Jeff Wilson, Michelle Molnar, Josh Thiessen, Amy Taylor; SERSC: James Bornemann, Marc-André Long and Caitlin Brawn

Reviewers: MNAI: Roy Brooke; SERSC: James Bornemann, Kirk Brewer, Caitlin Brawn, Marc-André Long

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Convening Organizations

Convening organizations: Smart Prosperity Institute, David Suzuki Foundation, Town of Gibsons, BC, and Roy Brooke and Associates were the original convening partners for the Municipal Natural Assets Initiative and the Cohort 2 project leading to this report was initiated by them.

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Cover Photo: MNAI

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Summary

The Municipal Natural Asset Initiative (MNAI) project was initiated by Southeast Regional Service Commission (SERSC) in partnership with the Town of Riverview to increase their understanding of how proper management of the natural assets within the community contribute to improved stormwater management. The focus of the project was a large development area proposed within the Mill Creek Watershed that is being designed adjacent to a nature park. The community wants to explore development that protects and enhances natural assets while incorporating planned recreational, institutional, commercial, and residential development.

This project included the development of a natural asset inventory, condition assessment, stormwater modelling, economic assessment and initial planning considerations. The findings demonstrate that the wetlands and surrounding natural areas within the Mill Creek watershed provide valuable storage capacity that if lost, will result in increased costs to Riverview to meet the regulatory requirements of the stormwater design criteria. The costs increase further if future climate conditions are factored in.

Modelling was completed for 4 wetlands to assess the volume and peak flow reduction for the 5-year storm event and the 100-year storm event. The model was run under current development conditions as well as with the proposed development and with and without climate change. Project results indicate that the existing wetlands are currently attenuating nearly 19,000 m^3 of total flow over 24 hours. Under future climate change conditions, the wetlands contribute an additional 284 m^3 of flow attenuation over a 24 hour period. Peak flows were also analyzed through the modelling, which found that the larger wetlands in the sub-catchment that drains below the Mill Creek Dam currently attenuate about 4.5% of peak flows, or 3.4% of peak flows under future climate change. The smaller wetland in the sub-catchment near the Operation Centre was found to be at its capacity to attenuate peak flows during the existing 100-year storm.

Modelling also revealed the importance of forest cover in reducing stormwater runoff. When comparing current development scenarios with the proposed development scenarios, the findings reveal that roughly 33,000 - 34,000 m^3 of runoff is controlled by the existing vegetation. Less effective on a per area basis than wetlands, forests also provide a valuable contribution to stormwater control services.

The replacement cost method was used to estimate the value of Mill Creek's natural assets, specifically the 4 wetlands in the project area. The cost of replacing the Mill Creek wetlands with stormwater management ponds or constructed wetlands to provide an equivalent detention function for stormwater was based on the required storage volume and costs to design and construct a stormwater detention pond with landscaping and environmental components. This was then compared to existing stormwater design criteria, which requires that post-development peak flows do not exceed those of pre-development.

The monetary value of stormwater services provided by the wetlands for a 5-year return period precipitation event was estimated at roughly $1.07 million under current climate conditions. Factoring in future development, increases the estimated cost to $2.30 million and under assumed future climate conditions, the costs increase even further to $2.41 million. The same pattern exists for the 100-year precipitation event. That is, the estimated value of stormwater services provided by the wetlands for a 100-year return period precipitation event was estimated at roughly $1.40 million under current climate. Factoring in future development, increases the estimated cost to $2.30 million and under assumed future climate conditions, the costs increase even further to $2.73 million. The figures above exclude land purchases. Neither do the values include a range of co-benefits including improvements to water quality, provision of wildlife and aquatic habitat, health and recreational benefits, transportation benefits, safety and social benefits, educational benefits, promotion of environmental sustainability and economic benefits.

Annual monitoring, operating and maintenance expenditures for both natural assets and an engineered alternative were approximated for this project. Three scenarios representing different options for the Mill Creek project area were considered. The first scenario assumed development is done in a way that avoids damaging existing wetlands and factors in the construction of some engineered stormwater infrastructure to offset the net peak flow impact from development. The second scenario assumed the existing wetlands could be enhanced to achieve the required peak flow offset from development. The final scenario assumed development damages wetland to the point where their stormwater function is eliminated, resulting in the need for a fully engineered replacement to control stormwater flows. Life cycle costs (capital + O&M expenditure over 100-year planning horizon) for scenarios were considered for both current and future climate conditions. Under current climate conditions, the existence of wetlands offsets the present value of lifecycle costs by $1.17 million. These reduced costs are slightly higher under projected future climate conditions with a present value of $1.19 million in avoided costs.

Currently, no operation and management plans have been developed for the wetlands, however a web-based tool has been created to view the natural asset inventory and condition assessment alongside engineered assets. The tool and the modelling work completed for this project helps build a case for actively managing these wetlands to ensure they continue to provide services indefinitely. By doing so, the Town of Riverview can avoid the capital cost of building engineered alternatives while improving data accessibility for on-going decision-making.

This project was reviewed by the Town and agreement was reached to work with SERSC and municipal council to modify existing by-laws to implement project findings. Relevant policies have been identified and/or are under review. SERSC is also supporting municipal partners to establish GIS-based asset management plans that consider both engineered and natural assets.

Introduction

The term "municipal natural assets" refers to the stock of natural resources or ecosystems that is relied upon, managed, or could be managed by a municipality, regional district, or other form of local government for the sustainable provision of one or more local government services (MNAI, 2017). By conceptualizing nature as an asset, we can codify, measure, and monitor the ways in which we depend on and impact the environment. Business and economic activity depends on natural assets to provide important inputs into production such as clean water, minerals, and timber. Natural assets are also important to human physical and social well-being. Benefits in terms of better air quality, water quality and climate stability as well as protection from flood, erosion and impacts of extreme weather events are well established. Urban greenspaces, parks, wetlands and protected areas provide important recreation spaces and buffer the effect of extreme heat in urban settings reducing the prevalence of respiratory infections and heat related illnesses. If natural assets are not managed responsibly, their value depreciates as does their ability to provide services from which humans benefit. Indeed, like any asset, natural assets need to be carefully managed to ensure a sustainable supply of services.

Communities like Riverview recognize that it is as important to understand, measure, manage and account for natural assets as it is for engineered ones. The Municipal Natural Asset Initiative (MNAI) project was initiated by the Southeast Regional Service Commission (SERSC) in partnership with the Town of Riverview to increase their understanding of how proper management of the natural assets within the community contributes to improved stormwater management. In this case, in their role of supporting municipalities within their regional jurisdiction, SERSC conducted the work on behalf of the Town of Riverview (see Box 1). The Town of Riverview was regularly consulted on key aspects of the project and provided essential input and data. This report summarizes the results of the Riverview project. It is organized as follows:

- This **Introduction** chapter describes the project objectives, the study area and provides a brief overview of the relevant natural assets.
- The **Approach** chapter describes the modelling approach that was employed to assess the contribution of the assets to stormwater management as well as key data sources that informed the analysis.
- The **Natural Assets Assessment** chapter describes the quantity and condition of natural assets in the study area.
- The **Planning for Natural Assets** chapter provides direction on how to manage the natural assets for improved stormwater management.
- The **Implementation of Natural Assets Plan** chapter describes specific actions that should be considered as a natural asset plan to protect the natural assets of interest.
- The **Conclusion** chapter summarizes the approach and findings of the project and articulates next steps and key priorities for Riverview.
- **Appendices** at the end of the report contain additional information of relevance to the project and associated outcomes.

Objective

The goal of the Riverview MNAI project was to minimize stormwater management infrastructure through the management of natural assets in the Mill Creek area of Riverview.

The key objectives of the project were to:

- Establish a natural asset inventory and condition assessment for key natural assets.
- Develop an understanding of existing natural assets and their actual or potential contribution to stormwater management within the Mill Creek watershed.
- Identify upstream options to support the effectiveness of Mill Creek's natural assets.

Project Area

The Town of Riverview is located in southeastern New Brunswick, adjacent to the communities of Moncton and Dieppe. The community has an approximate population of 20,000 and lies on the southern side of the Petitcodiac River. The focus of this project is the Mill Creek watershed, which has an approximate size of 47 km^2 and drains to the Petitcodiac River by way of Mill Creek through the Mill Creek Nature Park (Figure 1). The Town of Riverview recognizes that the area surrounding the Mill Creek Nature Park (Figure 2) could become the next regional residential, commercial, and recreation destination (Town of Riverview, 2013).

Box 1: About the Southeast Regional Service Commission (SERSC)

In 2013, the province of New Brunswick adopted a new governance model and created 12 Regional Service Commissions to provide mandated and optional services through cost sharing agreements. The Southeast Regional Service Commission's planning branch provides land planning and related services to the 12 municipalities and 3 unincorporated areas in the region. They are also tasked with the creation of a regional plan that provides oversight for municipal plans and that includes many different initiatives that are ongoing such as climate change plans, asset management, trail development and flood mapping. The Southeast Regional Service Commission's work with the MNAI team helped to refine these initiatives and provided the Commission with new tools to incorporate natural assets into policy within a regulatory framework.

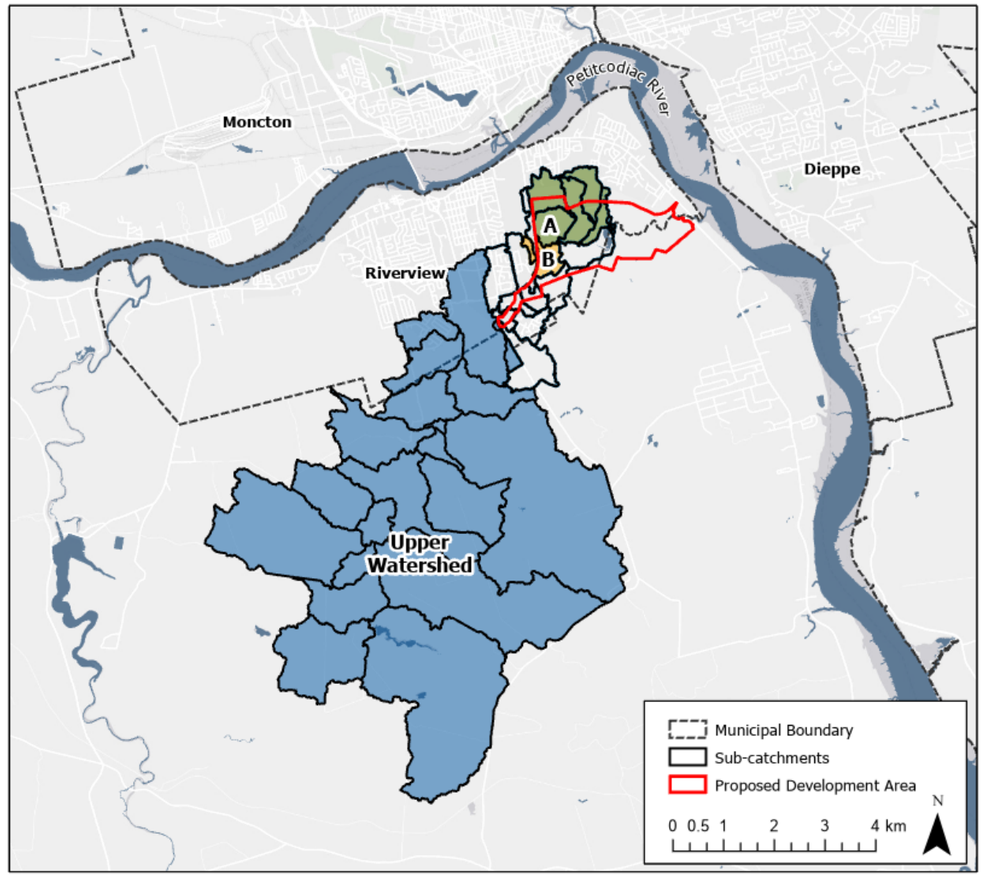

Figure 1. Mill Creek watershed and areas of interest for this modelling project. Source: SERSC

The upper portion of the watershed extends outside and to the south of the municipal limits (Figure 1). The land use in this area is primarily forestry. Since 2000, approximately 22% of the watershed has been harvested. The majority of the harvesting is on Crown lands that are managed under Crown License 7 with the objective of maximizing the wood supply over a 100-year planning horizon while also meeting other ecological, economic and social goals (J. D. Irving, 2014). A smaller portion of the watershed consists of private woodlots that have had minimal forest loss since 2000. Infrastructure along Mill Creek within the municipality includes two road crossings and a dam. The road crossing at Pine Glen Road was recently rebuilt following a washout and was designed to accommodate climate change and to avoid blockage from woody debris. The second road crossing at Route 114, is provincial infrastructure and is planned to be upgraded in the coming years. The dam that forms a notable pond within the Mill Creek Nature Park, was constructed in 1959, is in need of repair and is known to be under designed (GEMTEC Limited, 2012). There are no residences or other buildings at risk of flooding in the area.

A large development project is proposed within the Mill Creek Watershed (Figure 2). It is being designed adjacent to the nature park with the intention of incorporating nature to provide a seamless transition from the proposed development to the nature park. The community wants to explore development that protects and enhances natural assets while incorporating planned recreational, institutional, commercial, and residential development.

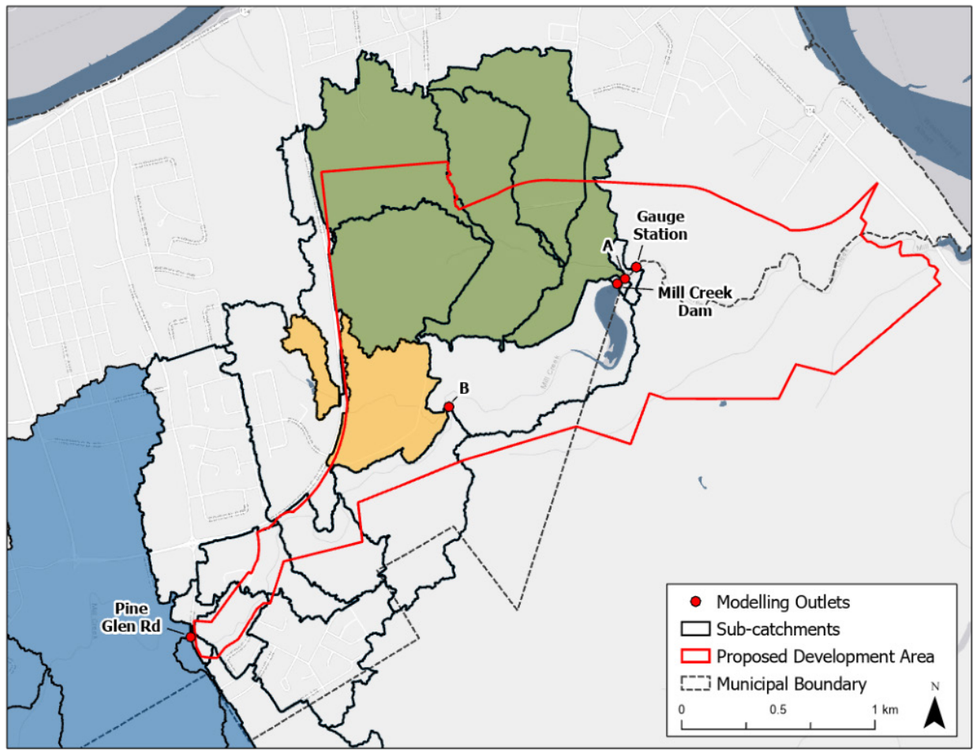

Figure 2. Proposed development area in relation to Mill Creek sub-watersheds. Source: SERSC

Natural Asset Focus

MNAI defines natural assets as ecosystem features that are nature-based and provide services that would otherwise require equivalent engineered infrastructure (MNAI 2017). For local governments, natural assets can include forests that convey stormwater and recharge aquifers, wetlands that reduce flooding risk, and coastal areas that protect against storm surges and sea level rise, among others. By identifying natural assets at the community level and prioritizing those in municipal asset management portfolios, local governments can deliver vital municipal services, often at lower costs. Local governments will also be better prepared to deal with the effects of climate change.

For this project, the goal was to identify key natural areas within the Mill Creek watershed to be retained as natural assets to minimize engineered stormwater management infrastructure costs associated with the new development. Figure 3 shows the potential location of development.

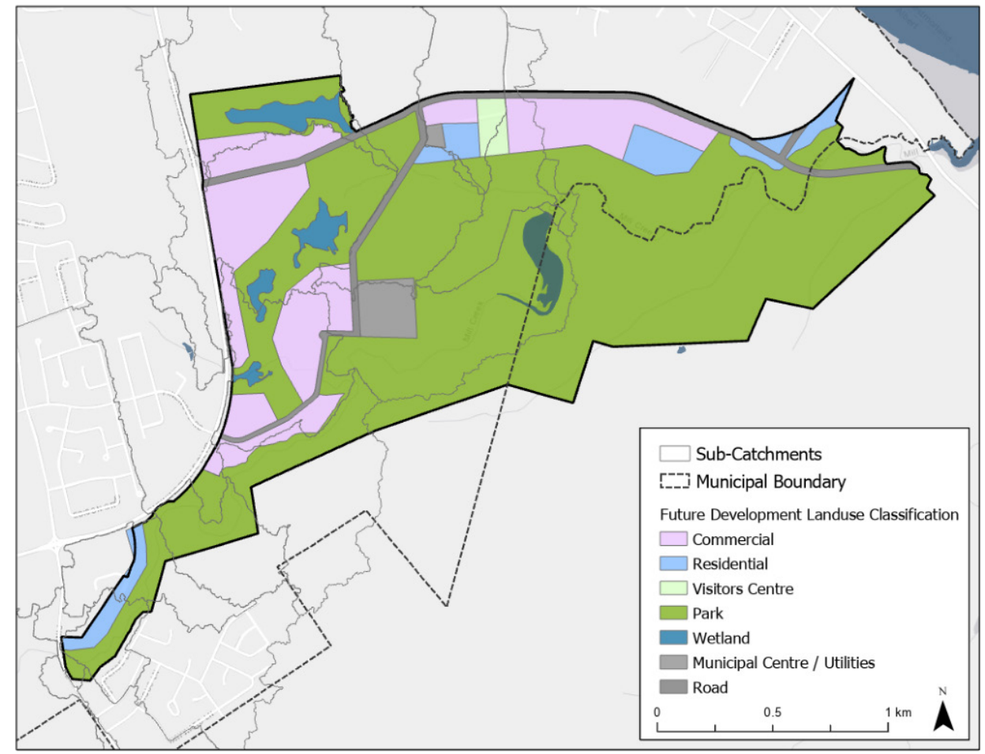

Figure 3. Proposed development areas for commercial and residential areas surrounding the Mill Creek Nature Park and important natural assets. Source: SERSC

Knowing that development is planned for this portion of the Mill Creek watershed, the analysis focused on natural areas within and surrounding the Mill Creek nature park that could be retained and managed to help control the increased stormwater associated with the new development plans.

Approach

This section of the document describes the approach employed to complete the Riverview project. An overview of the MNAI approach is provided along with a more detailed description of the modelling work that was completed.

MNAI Approach

MNAI's natural asset methodology is rooted in modern, structured asset management processes. The methodology generally follows the standard asset management assess, plan and implement steps, highlighting novel considerations required for local natural assets and associated services.

MNAI has a range of tools, including templates and guidelines, that are configured for use according to local government needs. The methodology and tools are delivered through ongoing support from the MNAI technical team over the project life. The levels and details of this support are described in a Memorandum of Understanding that MNAI signs with local government partners.

Asset management strategies require a multi-disciplinary, team-based approach. The MNAI process therefore begins with an initial engagement session with local government representatives from numerous disciplines. This includes, for example, representatives from Parks, Public Works, GIS, Engineering, Planning, Water and Wastewater, and Finance. During the initial engagement session, plans and priorities of the community are discussed, and key natural assets within the jurisdictional boundaries of the community are identified along with the important services they provide. Site visits to the natural assets were undertaken and key geophysical features observed and documented. The objectives of this initial engagement session are to identify:

- the natural asset/s that will be the focus of the natural asset assessment,
- the geographic boundary(ies) of the focus assets,
- the skillsets and expertise of relevance to the natural asset assessment,
- local government personnel that will engage in the assessment process, and
- data needs of the assessment and the sources for the relevant data.

The initial community engagement session for the Riverview project took place on May 23-24, 2018. It was attended by representatives from numerous municipal government departments including Engineering, Recreation, Economic Development, and Finance. Appendix A contains the agenda for the session along with a list of participants. At the completion of the session, the focus on the role of natural assets in supporting improved stormwater management for future development within the Mill Creek watershed was established.

Following the initial community engagement session, the MNAI team works with the target community to complete a natural asset assessment. The assessment generally involves the following steps:

1. Defining the scope of natural assets to be considered.
2. Inventorying the natural assets by collecting and organizing existing information about the assets.
3. Conducting a condition assessment of the assets.
4. Conducting a risk assessment of the assets.
5. Quantifying existing service levels from the assets.
6. Developing scenarios to explore alternative management plans and future implications to existing service levels.
7. Quantifying service levels under alternative scenarios.
8. Developing operation and management plans based on existing conditions, risks, and desired service level trajectories.

These steps were completed for Riverview with a focus on improving stormwater management in the Mill Creek watershed.

The scope of the project was determined by weighing the project objectives against data availability and proposed modelling and economic approaches. The asset inventory was informed by land cover data obtained by the local government. The condition and risk assessment were conducted in consultation with local government and community representatives, including Ducks Unlimited. The same approach was taken to defining the alternative management scenarios and future implications to existing service levels. As is described in detail below, six scenarios were assessed for Riverview. The modelling approach employed to quantify the service levels under the alternative scenarios (Step 7 above) is described below.

Modelling Approach for Scenario Analysis

As is noted above, the natural assets of interest to the current project are the natural areas, particularly the existing wetlands, within the Mill Creek watershed, and the role they play in controlling stormwater.

HEC-HMS software was used to create a hydrologic model of the Mill Creek watershed. This is a freely available software, which can run both continuous and event-based simulations at a variety of time-steps. HEC-HMS allows users to create a hydrologic model that uses a variety of hydrologic parameters (e.g. runoff, evaporation, snowmelt) to estimate the runoff from a watershed for a given rainfall event, based on a suite of physical characteristics for a given watershed (e.g. size, slope, length/width, surface cover, soil types). For this project, an event-based model was created to evaluate runoff given a variety of land cover and climate scenarios. The modelling results were used to inform service levels provided by natural assets and to help quantify the value of natural assets.

The purpose of the modelling was to understand and quantify the hydrologic benefit of existing wetland features and vegetation in the project area, as well as evaluate the potential impacts of development. When addressing these questions, it was important to keep in mind Riverview's stormwater design criteria (Town of Riverview, 2011), which state: "for all development, peak post-development flows should not exceed pre-development flows for all storms up to the major drainage system design storm." This sets the requirement for managing flows from any new development. The criteria further state that "all areas of new development within the Town of Riverview shall be designed using the Dual Drainage Concept (Minor/Major systems) to achieve specific levels of service."

As a result, modelling efforts focused on precipitation events that align with the minor and major systems design criteria.[1] The modelling also assessed the relative benefit of the natural assets under several upper watershed harvesting and climate scenarios. Specifically, the following model scenarios were developed:

Climate Scenarios

- Current climate:
  - 5-year precipitation events, which correspond with minor stormwater system regulations
  - 100-year precipitation events, which correspond with major stormwater system regulations
- Future climate (RCP 8.5, 2100):
  - 5-year and 100-year precipitation events

Landcover Scenarios

- Proposed development area:
  - Current landcover
  - Proposed development landcover
- Upper watershed:
  - Current forest conditions
  - Best case forest management
  - Worst case forest management

The purpose of developing the upper watershed scenarios was to assess the implications of forest harvesting on the flows downstream. As can been seen in Figure 1 above, the upper watershed represents a large geographic area relative to the project area and could therefore have a significant influence on flows within the Mill Creek project area.

1 The minor drainage system (e.g. roof gutters, swales, street gutters, storm sewers etc.) is intended to convey runoff from less intense, more frequent storms. The major drainage system (i.e. natural streams and valleys, man-made channels and ponds, etc.) is intended to accommodate runoff from more intense, less frequent storms.

Natural Asset Assessment

This section of the report presents the results of the assessment of natural assets within the Mill Creek project area. As is noted in the Approach section, the natural asset assessment process begins with the completion of an asset inventory.

Asset Inventory

To develop the asset inventory, existing land cover data was gathered and organized. Table 1 summarizes the primary data inputs used to establish the natural asset inventory.

TABLE 1 - SUMMARY OF DATA INPUTS USED FOR THE NATURAL ASSET INVENTORY

Dataset	Resolution	Source	Date(s)
Landcover	1m	SERSC[2]	2017
Forest Soils	Vector	GeoNB	2015
NBHN Wetlands	Vector	GeoNB	2018
Global Forest Loss	30m	ESA	2017

The data was organized and structured in ArcGIS software allowing the natural asset information to be summarized and analyzed alongside other spatial data. An Asset Identification (asset ID) structure was developed to nest different organizational levels of natural assets. This will help track specific assets as the inventory is expanded over time to include asset attributes, their individual condition, their relative contribution to services, and any management actions or prescriptions undertaken in the area.

The highest level of the ID structure captures watershed boundaries. The second level further specifies any sub-catchment boundaries. The third level differentiates between wetland and forest cover within each catchment boundary. Figure 4 shows the different landcovers within the sub-catchment areas. Sub-catchments were used to organize the natural assets since doing so provides a way to relate their services to storm water management.

2 The land cover data needed to be generated by the SERSC at a high resolution since publicly available data was only available at a lower resolution that missed many of the natural assets in the area.

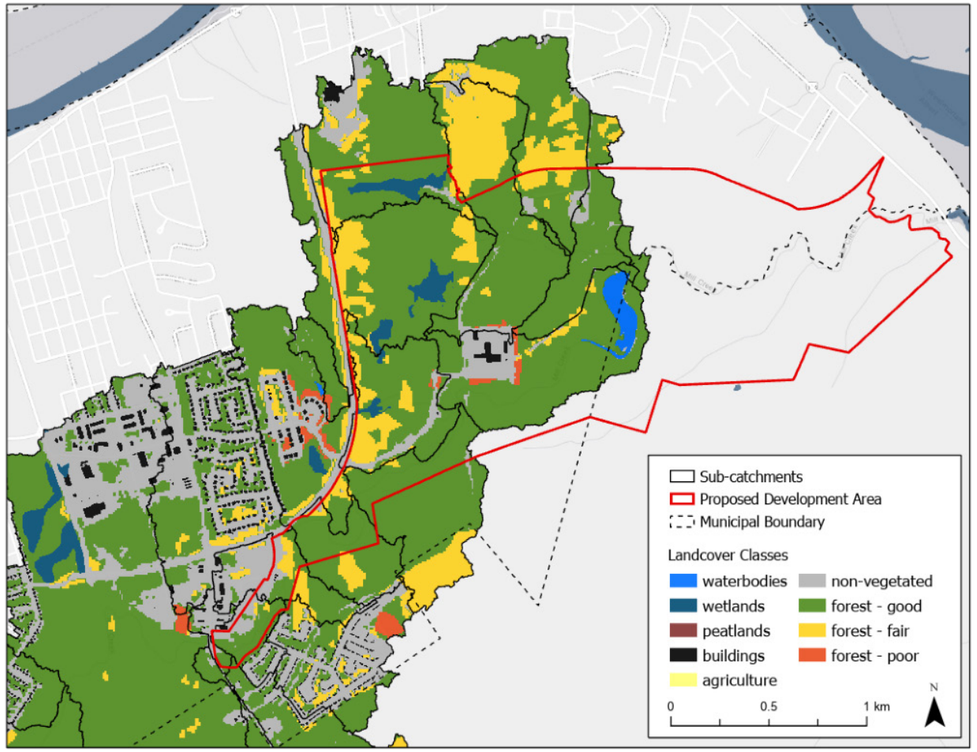

Figure 4. Sub-catchments and land cover classes used to create the natural asset inventory within the project area. Source: SERSC

The completed natural asset inventory contains information on the following attributes:

- Asset ID
- Asset Class
- Estimated stormwater capacity (for wetlands)
- Disturbed area within 1 km buffer (for wetlands)
- Vegetation health index (for forests; average NDVI[3] (vegetation index), 0=low, 1=high)
- Runoff index (for forests; average curve number, 0=low, 100=high)
- Percent of forest by condition (good, fair, poor)
- Physical condition rating

3 Normalized difference vegetation index

At the catchment level, additional aggregated asset inventory data was developed. Specifically:

- Average NDVI
- Average curve number
- Percent impervious surface
- Percent waterbodies
- Percent wetlands
- Percent buildings
- Percent agriculture
- Percent unvegetated
- Percent forest by condition (good, fair, poor)
- Physical condition rating

Condition Assessment

Condition assessments provide a high-level assessment of existing natural assets to inform future management actions and decision-making.

Once the inventory was established, land cover data was organized and summarized by watershed boundary to support the condition assessment process. The goal of the condition assessment was to provide Riverview with a high-level assessment of the existing natural assets to help inform future management actions and decisions pertaining to those assets. This was achieved by classifying the condition of watersheds to provide stormwater management services. Condition ratings range from very poor to very good and were allocated based on percent impervious surface within the watershed (Table 2 and Figure 5). A 'very good' condition rating reflects a catchment with natural assets largely intact with little ecological deterioration. Catchments with greater than 10% impervious surface typically experience negative effects to streams and wetlands due to erosion and increased sedimentation from increased runoff as described by the "urban stream syndrome". Restoration and/or maintenance may be required to improve and/or maintain their ecological function.

TABLE 2 - SUMMARY OF CRITERIA FOR SUB-CATCHMENT CONDITION RATINGS

Sub-catchment Condition	Criteria	Interpretation
Very good	0-5% impervious surface	Well maintained, good condition, no signs of deterioration in ecological conditions.
Good	5-10% impervious surface	Ecological conditions appear to be sufficient, some minor localized (or isolated) impacts noticeable, which may be a warning sign of possible decline.
Fair	10-20% impervious surface	Clear signs of deterioration in ecological function and service influencing factors.
Poor	20-30% impervious surface	Condition is below standard with large portion/s of the system exhibiting significant deterioration in ecological function.
Very poor	>30% impervious surface	Widespread signs of advanced deterioration, unlikely the natural asset is providing any functional service.

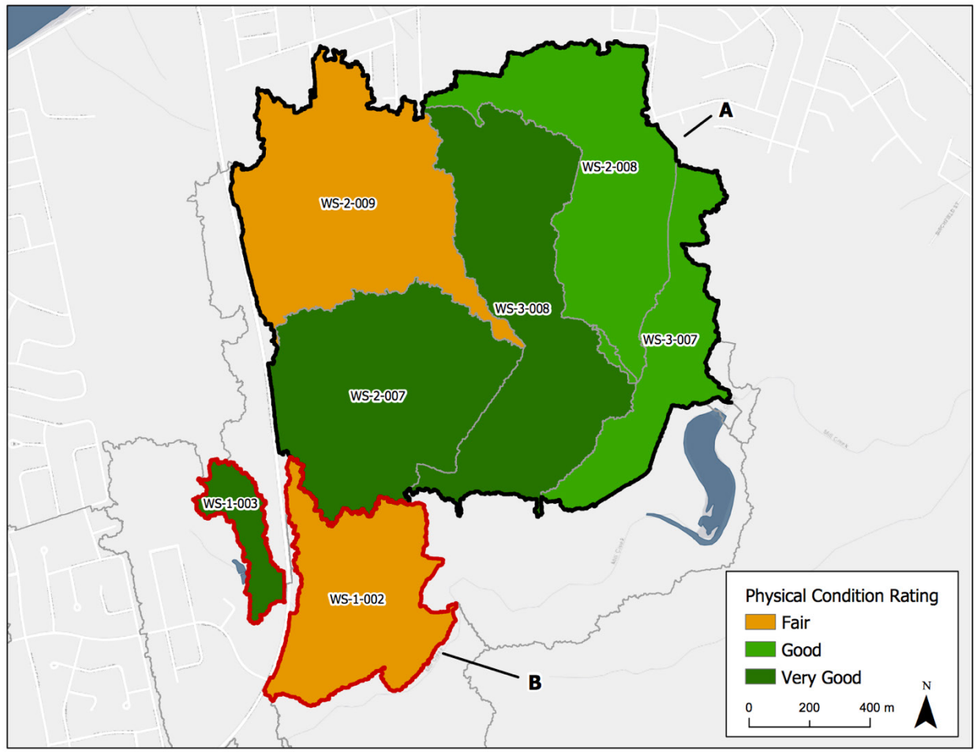

Figure 5. Watershed level condition rating for the project area. Source: SERSC

Individual wetlands were also allocated condition ratings. For some of the wetlands within the project area, a condition assessment had been completed by Ducks Unlimited in support of this project. Ducks Unlimited used a provincial standardized assessment tool called the Wetland Ecosystem Services Protocol (WESP).[4] For those wetlands with a WESP assessment, the condition rating was based on the function rating assigned by WESP protocol; for those without a WESP assessment, the wetland was allocated a score based on the percentage of area disturbed (e.g. impervious surface, forest harvested, road density, etc.) within 1 km of the wetland. Wetlands with a very good or good score are minimally impacted from surrounding land uses with good ecological function. Wetlands are impacted by surrounding land uses and have impaired function due to factors such as: ground compaction, partial infill, and sedimentation. For wetlands with impaired function, restoration is likely to be required to maintain functions and service levels. Ratings were allocated as follows:

- Very good = disturbed area is 0 - 25%
- Good = disturbed area is 26 - 50% or disturbed area is 0 - 25% with more than 1,000 m of road/km^2
- Fair = disturbed area is 51 - 75% or disturbed area is 26 - 50% with more than 1,000 m of road/km^2
- Poor = disturbed area is 76 - 100% or disturbed area is 51 - 75% with more than 1,000 m of road /km^2
- Very poor = disturbed area is 76 - 100% with more than 1,000 m of road/km^2

4 For more information on WESP see: Adameus (2018). Chapter 4.3.2 – WEST (Wetland Ecosystem Services Protocol): A suite of regionalized RAMs. https://doi.org/10.1016/B978-0-12-805091-0.00011-6

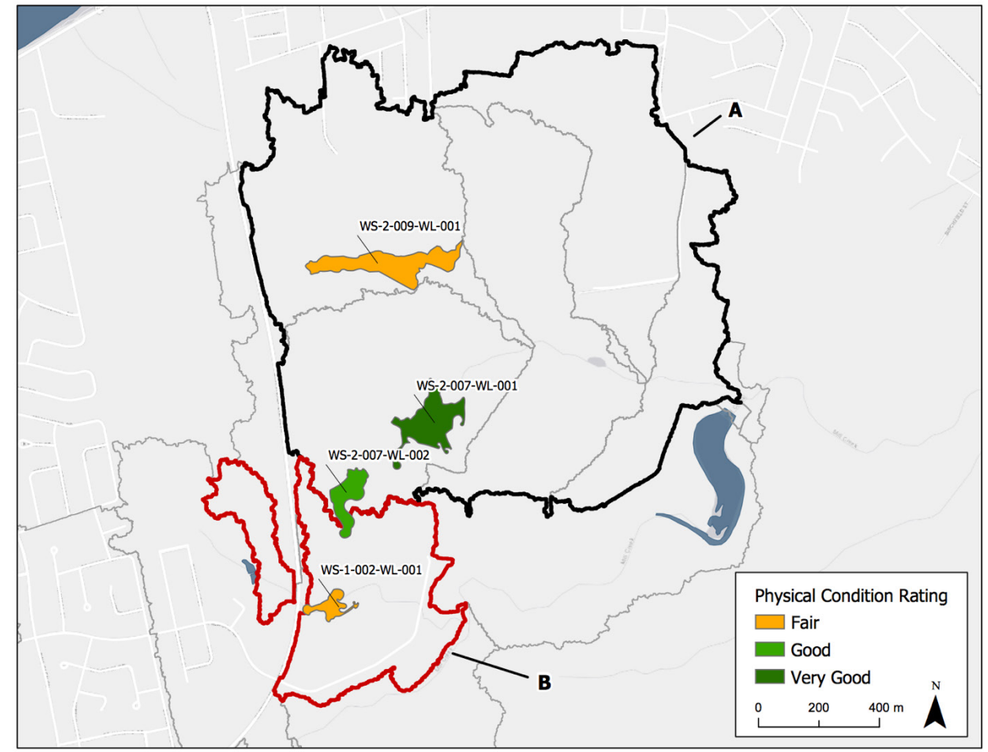

Figure 6. Wetland condition ratings for the project area. Source: SERSC

Figure 7. Wetland WS-2-009-WL-001. Source: Ducks Unlimited, 2018

Wetland WS-2-009-WL-001 (Figure 7) is designated by the province of New Brunswick as a regulated wetland and has an unnamed tributary that flows into Mill Creek. This wetland scored high in 5 of 17 wetland functions or attributes, according to WESP criteria.

Figure 8. Wetland WS-2-007-WL-001. Source: Ducks Unlimited, 2018

Wetland WS-2-007-WL-001 (Figure 8) is not designated by the Province of New Brunswick as a wetland and therefore does not fall under the Wetland Provincial Policy. This wetland scored high in 10 wetland functions or attributes according to WESP criteria.

Figure 9. Photo of wetland WS-1-002-WL-001. Source: Ducks Unlimited, 2018

Wetland WS-1-002-WL-001 (Figure 9) is not designated by the Province of New Brunswick as a wetland but is contiguous with an unnamed tributary that flows into Mill Creek. This wetland scored high in five wetland functions or attributes according to WESP criteria.

Forest cover conditions in each catchment area were allocated condition ratings based on percent forest harvested since 2000 (Figure 10). Areas with a “very good” score have largely intact forest with good ecologic function. Those with poorer scores have younger forest stands that have less hydraulic and other ecological functions.

- Very good = 0-20% of area is disturbed
- Good = 21-40% of area is disturbed
- Fair = 41-60% of area is disturbed
- Poor = 61-80% of area is disturbed
- Very poor = 81-100% of area is disturbed

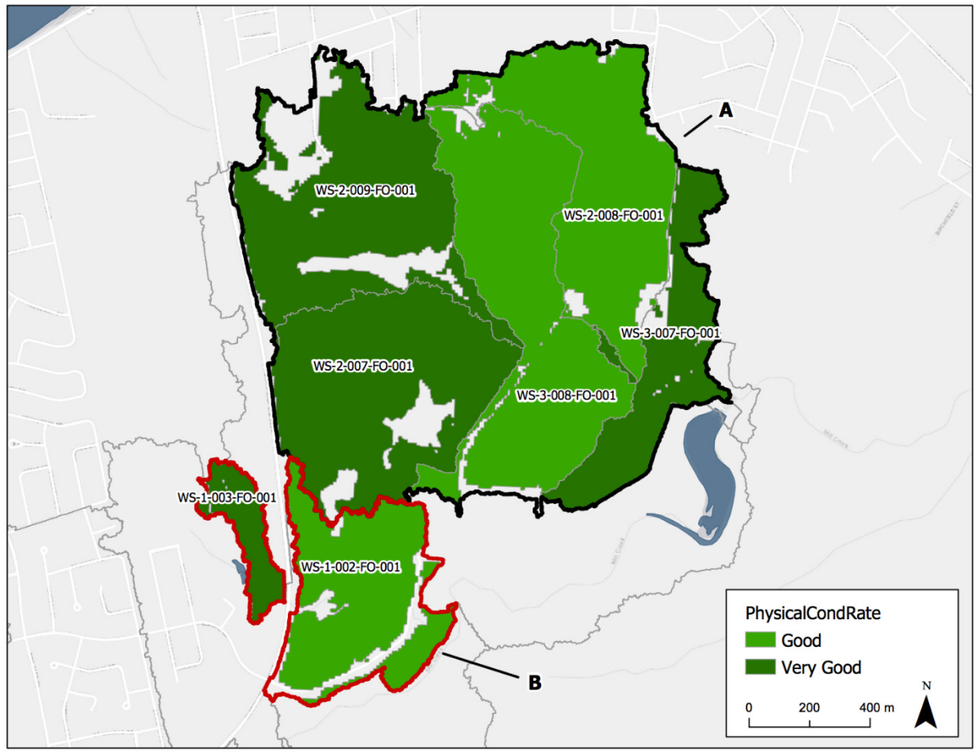

Figure 10. Forest condition ratings within the project area. Source: SERSC

Natural Asset Inventory and Condition Web-Tool

A web-based tool was created to view the natural asset inventory and condition assessment. The purpose of the tool is to provide an equivalent way to view the natural assets as is currently being developed for engineered assets. By creating equivalent natural and engineered asset inventories, the integration of natural assets into traditional asset management systems is promoted. In addition, web-based applications allow users to access natural asset inventory data and information in the field as well as from desktops.

The web-based tool viewer (Figure 11) allows users to explore assets of interest within the Mill Creek Watershed. As described above, the natural asset inventory uses an ID structure that nests assets within their sub-catchment. This same structure is used in the web-based tool allowing users to explore assets by their location within a sub-catchment. Additionally, users can select all assets of one type (e.g. wetland, forest), explore assets by their condition rating (very poor to very good), or select an individual asset of interest. Relevant information is displayed in the web-based tool for the user's asset or assets of interest including average NDVI, runoff potential, and total wetland capacity, when relevant.

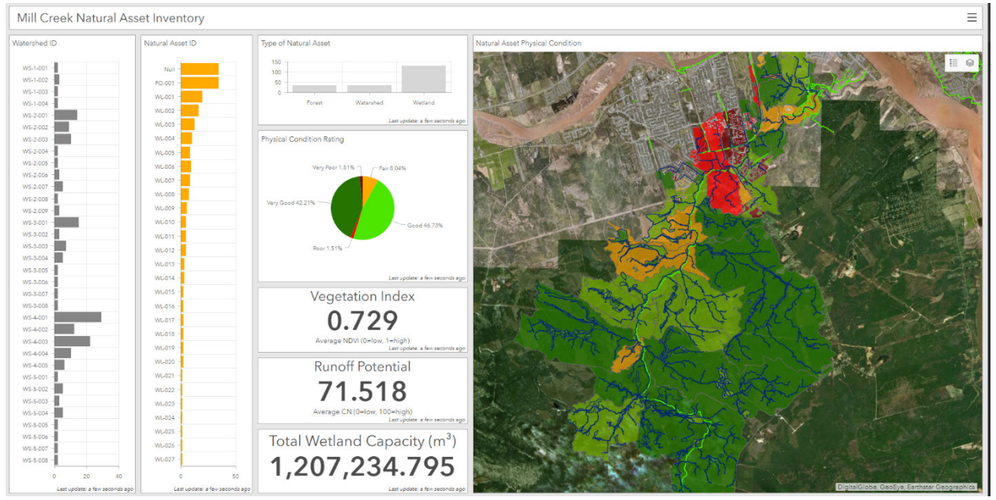

Figure 11. A screen shot of the Mill Creek natural asset web-based viewer. Source: SERSC

Stormwater Management Benefits

This section explores the stormwater management benefits of the wetlands in the proposed development area (sub-catchments A and B, as seen in Figure 2). While the asset inventory and condition assessment captured a range of natural assets in the Mill Creek project area, the modelling analysis examined the level of stormwater management services provided by the 4 wetlands within the project area (Figure 6). The quantification of the service levels provided by these wetlands was based on comparing hydrologic model results with and without the wetlands. This provided a quantification of the relative contribution of the wetlands to stormwater management. The model was also run under current development conditions as well as with the proposed development and with and without accounting for climate change. Table 3 summarizes key outputs from the model.

TABLE 3. SUMMARY OF MODEL OUTPUTS BY SCENARIO.

	Historic 100-year Storm	Climate Change 100-year Storm
	Cubic metres within 24 hours	
Current Development with Wetlands	250,407	324,879
Current Development without Wetlands	269,375	344,132
Contribution of Wetlands (Current Development)	18,968	19,252
Proposed Development Plan Conserving the Natural Assets	284,272	360,210
Proposed Development Plan without Wetlands	302,635	378,740
Contribution of Wetlands (Proposed Development)	18,363	18,530

The results of the modelling indicate that the existing wetlands are currently attenuating nearly 19,000 m^3 of total flow over 24 hours, or about 7% of the total flow volume. Under climate change conditions, the wetlands contribute an additional 284 m^3 of flow attenuation over a 24 hour period. The proposed development in areas surrounding the wetlands reduces the wetlands net ability to attenuate flows. Under the proposed development scenario, wetlands still

provide a significant benefit, reducing flow volumes over 24 hours by over 18,000 m^3, or about 6% of total flow volume. Under climate change conditions and with the proposed development, the wetlands contribute an additional 167 m^3 of flow attenuation.

It was found that under the future climate scenario peak flow for 1:100 year return period increased by ~30% for the sub-catchments A and B. These results show that in this location, current storm water guidelines of multiplying magnitudes/ volumes by 20% to accommodate for climate changes were insufficient.

An important consideration when comparing current development scenarios with the proposed development scenarios is that existing vegetation (i.e. forest cover) that is converted to developed land also plays a role in reducing runoff; roughly 33,000 - 34,000 m^3 of flow volume is controlled by the existing vegetation. Less effective on a per area basis than wetlands, the forested area still provides a valuable stormwater management service.

Peak flows were analyzed through the modelling. Tables 4 and 5 summarize these results. In the case of the tributary outlet near the Operation Centre, wetlands contribute to reducing peak flows. However, the results demonstrate that the wetlands have limited ability to attenuate peak flows under climate change. In other words, the small wetland in watershed B (Figure 6) is already at its capacity to attenuate peak flows during existing 100-year storm events.

TABLE 4 - SUMMARY OF PEAK FLOW MODEL OUTPUTS BY SCENARIO FOR THE TRIBUTARY OUTLET NEAR THE OPERATIONS CENTRE

	Historic 100-year Storm	Climate Change 100-year Storm
	Peak flow (cubic metres per sec)	
Current Development with Wetlands	3.326	4.236
Current Development without Wetlands	3.362	4.270
Contribution of Wetlands (Current Development)	0.036	0.034
Proposed Development Plan Conserving the Natural Assets	3.784	4.669
Proposed Development Plan without Wetlands	3.795	4.679
Contribution of Wetlands (Proposed Development)	0.011	0.010

In watershed A, for the tributary outlet below Mill Creek Dam, there are 3 wetlands with larger storage capacities A (Figure 6). These wetlands thus have a great ability to attenuate peak flows as well as adapt to flows associated with climate change. Overall, the wetlands currently attenuate about 4.5% of peak flows, or 3.4% of peak flows under climate change. When considering the proposed development scenarios, the wetlands still provide important peak flow attenuation, however it is reduced by about 30 - 35%.

TABLE 5. SUMMARY OF PEAK FLOW MODEL OUTPUTS BY SCENARIO FOR THE TRIBUTARY OUTLET BELOW THE MILL CREEK DAM

	Historic 100-year Storm	Climate Change 100-year Storm
	Peak flow (cubic metres per sec)	
Current Development with Wetlands	11.646	15.063
Current Development without Wetlands	12.197	15.600
Contribution of Wetlands (Current Development)	0.512	0.537
Proposed Development Plan Conserving the Natural Assets	12.793	16.181
Proposed Development Plan without Wetlands	13.148	16.531
Contribution of Wetlands (Proposed Development)	0.355	0.350

Value of Stormwater Management Benefit

The replacement cost method was used to estimate the value of Mill Creek's natural assets, specifically the 4 wetlands in the project area (Table 6). The replacement cost approach assumes that a natural assets value is at least equal to the cost of replacing the assets with an engineered alternative capable of providing the same level of stormwater service. The value of the engineered alternative is seen as a minimum estimate for the value of the services provided by the natural assets because natural assets provide a range of benefits (e.g. recreational opportunities) beyond those provided by the engineered alternative (in this case stormwater management). Thus, in the context of this project, the replacement cost values presented in Table 6 reflect the cost of building an engineered alternative capable of storing the equivalent amount of water as is stored by the 4 wetlands under consideration. The co-benefits provided by the wetlands within the project area are described below. The cost of replacing the Mill Creek wetlands with stormwater management ponds or constructed wetlands to provide an equivalent detention function for stormwater was based on the required storage volume and an assumed cost of $175 per cubic meter.[5] This unit volume cost reflects the design and construction for a stormwater detention pond with landscaping and environmental components and excludes land purchase.[6]

5 The value $175 per cubic metre is based on values estimated for Gibsons, BC. For more details see:

Sahl, J., Hamel, P., Molnar, M., Thompson, M., Zawadzki, A. and Plummer, B. (2016). Economic Valuation of the stormwater management services provided by the Whitetower Park ponds, Gibsons, BC. This appears to be a conservative estimate based on other literature. For instance, in the US the EPA estimates an average value of $6.80 per cubic foot (or $240 per cubic metre): https://www3.epa.gov/region1/npdes/stormwater/ma/green-infrastructure-stormwater-bmp-cost-estimation.pdf

6 Vacant Land within the sturdy area was valued at roughly 10-70 times less than the value of the wetlands for stormwater control under the range of replacement costs in Tables 5 and 6.

TABLE 6. REPLACEMENT COST FOR THE WETLANDS IN THE PROJECT AREA			
Wetland ID	**Surface Area (m^2)**	**Storage Capacity (m^3)[7]**	**Replacement Cost**
WS-2-009-WL-001	8,904	21,452	$ 3.75 M
WS-2-007-WL-001	3,889	10,391	$ 1.82 M
WS-2-007-WL-002	407	3,275	$ 0.57 M
WS-1-002-WL-001	591	1,378	$ 0.24 M
Sum of all Wetlands	13,791	36,496	$ 6.39 M

Table 6 provides an estimate of the cost to completely replace the total storage capacity of the existing wetlands, which is an important variable to capture in a natural asset inventory. However, based on existing stormwater design criteria, the actual replacement stormwater capacity should be based on ensuring post-development peak flows do not exceed those of pre-development. Another metric of relevance to the analysis therefore, is the cost of engineered assets that would be required to ensure that the peak flow of water remains the same or lower given alternative development and climate scenarios. In this case, the focus is on the amount of storage required to limit the flow, as opposed to the amount of storage provided by the wetlands. This is the focus of Table 7.

Table 7 summarizes analysis of stormwater replacement costs from the perspective of existing stormwater design criteria (i.e. ensuring post-development peak flows do not exceed those of pre-development) and includes all the modelled scenarios relative to the baseline conditions. The first row in the table represents the baseline flow conditions; the flow rate of 4.61 m^3/second is based on current (historic) climate conditions, a 5 year return period, current land cover, and assumes the 4 wetlands are in place and functioning. This flow is the rate that should be maintained considering a range of alternative climate and development scenarios. The second row of the table is based on the same return period, land cover and climate conditions, but assumes the 4 wetlands are removed. In this case, the maximum flow increases to 5.13 m^3/second. To limit the maximum design outflow to 4.61 m^3/second (the baseline flow presented in the first row of the table), thus requires engineered storage capacity of 6,132 m^3 at a cost of roughly $1.07 million. Factoring in future development (and accounting for the loss of stormwater management services provided by forested lands), the third row of the table demonstrates that storage of 13,129 m^3 is required at a cost of roughly $2.30 million. Under assumed future climate conditions these increase further to 6,718 m^3 and 13,778 m^3 with and without development, respectively. The same pattern exists for a 100-year precipitation event.

7 Regression equations were utilized to estimate the storage capacity of the wetlands using known surface area. Several equations have been developed by organizations and researchers such as Ducks Unlimited Canada (DUC) (2008), Gleason et al. (2007) and Wu et al. (2015). Gleason et al. (2007) equation was chosen because they provide a simple assumption for springtime precipitation and runoff in their report. They considered the wetlands to be 50 % full at the start of their simulations in May.

TABLE 7. SUMMARY OF MAX FLOW, MAX DESIGN OUTFLOW, REQUIRED STORAGE, AND REPLACEMENT COST BY SCENARIO							
Climate Scenario	**Return Period**	**Land Cover Scenario**	**Wetlands**	**Max Flow (m^3/s)**	**Max Design Outflow (m^3/s)**	**Storage Volume Required (m^3)[8]**	**Replacement Cost ($ millions)**
Current	5	Current practices	Yes	4.61	-	-	-
Current	5	Current practices	No	5.13	4.61	6,132	1.07
Current	5	Future development	Yes	5.57	4.61	9,846	1.72
Current	5	Future development	No	5.90	4.61	13,129	2.30
Current	100	Current practices	Yes	11.65	-	-	-
Current	100	Current practices	No	12.20	11.65	7,990	1.40
Current	100	Future development	Yes	12.79	11.65	12,759	2.23
Current	100	Future development	No	13.15	11.65	15,623	2.73
Climate change	5	Current practices	Yes	6.36	-	-	-
Climate change	5	Current practices	No	6.87	6.36	6,718	1.18
Climate change	5	Future development	Yes	7.34	6.36	10,662	1.87
Climate change	5	Future development	No	7.67	6.36	13,778	2.41
Climate change	100	Current practices	Yes	15.06	-	-	-
Climate change	100	Current practices	No	15.60	15.06	8,803	1.54
Climate change	100	Future development	Yes	16.18	15.06	13,614	2.38
Climate change	100	Future development	No	16.53	15.06	16,499	2.89

The key point from Table 7 is that the wetlands provide valuable storage capacity that if lost, would result in increased costs to Riverview to meet the regulatory requirements of the stormwater design criteria. These costs are higher when climate change conditions are factored in. In other words, the value of the wetlands is anticipated to increase based on future climate projections.

8 Storage volume required (24 hour volume) was interpolated by estimating the difference in area between the hydrographs for each scenario.

Natural Asset Co-benefits

This project is focused on the value of stormwater management benefits from natural assets in the Mill Creek watershed. Estimated values (presented above) account for the cost of providing equivalent stormwater management services from engineered assets. They do not account for the value of other services provided by natural assets such as access to green and recreational space for residents, hydraulic detention, and water quality functions. Consideration of these co-benefits would increase the estimated service value of the wetlands. Because of this, care must be taken to acknowledge the range of co-benefits from the natural assets of interest to decision-makers. Economic and policy decisions that focus narrowly on the trade-offs between conventional infrastructure and natural infrastructure may overlook the broader range of benefits to the potential detriment of the surrounding community.

In addition to stormwater management benefits, the naturalized trails, meadows, wetlands and riparian areas of the project site provide a range of co-benefits including improvements to water quality, provision of wildlife and aquatic habitat, health and recreational benefits, transportation benefits, safety and social benefits, educational benefits, promotion of environmental sustainability, and economic benefits.

Table 8 reviews the co-benefits of significance to the Mill Creek watershed. Each co-benefit of interest includes a review of its significance, whose welfare is improved by the existence/flow of the co-benefit (the beneficiaries), as well as potential ways to track these additional benefits.

TABLE 8 - CO-BENEFITS OF NATURAL ASSETS IN MILL CREEK

Co-benefit	Significance	Beneficiaries	Possible assessment method
Water quality maintenance	Support food chains in receiving waters; support coldwater fish and other aquatic life; maintain quality of receiving waters; shoreline protection from erosion	Population within catchment and downstream catchments	Wetland Ecosystem Services Protocol for Atlantic Canada (WESP-AC)
Provision of wildlife and aquatic habitat	Support for an abundance and diversity of native fish, invertebrate animals, amphibians and reptiles, nesting waterbirds, songbirds, raptors and mammals, as well as native plants and pollinators. Provision of space for public use including recreation, education and research.	Local wildlife (terrestrial and aquatic); local population and tourism population	Wetland Ecosystem Services Protocol for Atlantic Canada (WESP-AC)
Health and recreation	Provision to people of all ages with attractive, safe, accessible and low-to-no-cost places to cycle, walk, hike, jog or skate; reduced health care costs. In a cost-benefit analysis of trails (Wang et al., 2004), it was estimated that for each dollar spent on building, maintaining and using trails, nearly three dollars are realized in reduced health care costs by trail users due to improvements in their health.	Sub-population of trail users; public health agencies	Trail survey, administered every 3-5 years to track relevant indicators
Transportation /livability	Provision of viable transportation corridors, which can be a crucial element of a seamless urban or regional multi-modal transportation system; avoidance of congested streets	Sub-population of trail users; local and regional transportation departments	Trail survey, administered every 3-5 years to track relevant indicators
Safety and social benefits	Increased opportunities for social interactions, connection between trail users, community space and natural surroundings, which can result in improved self-image and social relationships, reduced crime rates and encouragement for youth to spend time in nature. Development of partnerships among private companies, landowners, neighbouring municipalities, local government, and advocacy groups. Community cohesion improved via trail elements of local character and regional influence.	Local population, tourist population, local police department(s), local business and advocacy groups	Trail survey, administered every 3-5 years to track relevant indicators
Educational benefits	Provision of outdoor classroom to experience nature, history and culture and place-based learning experience. Preservation of important natural landscapes, reduction of fragmented habitat, opportunities for protecting plant and animal species, wetland preservation. Improvements to air and water quality.	Local population, particularly school-aged population	Trail survey, administered every 3-5 years to track relevant indicators
Environmental sustainability benefits	Provision of opportunity for people to interact and experience nature in an immersive way. Increased awareness of wilderness value within communities. Pollution prevention and reduction of greenhouse gas emissions.	Sub-population of trail users	Trail survey, administered every 3-5 years to track relevant indicators
Economic benefits	Promotion of wellness and recreational tourism, leading to significant economic benefits. Increase in business revenues and property values for those near trails. Tourism BC (2009) conducted research that demonstrated 25 – 30% of all travellers in North America who participate in either hiking or biking chose their destination specifically for these types of recreation.	Local government and businesses	Trail survey, administered every 3-5 years to track relevant indicators

Planning for Natural Assets

The effectiveness of a natural asset within a stormwater management plan needs to be measured periodically to ensure that the natural asset's performance is functioning as expected over time. Thus, a management plan for the wetlands within the project area should be established.

A management plan sets out strategies and tasks for conservation, land use, interpretation, operations, and maintenance of the natural assets under consideration. The goal of such a plan is to ensure management decisions protect and enhance natural assets and that human use does not cause unacceptable impacts to their condition and level of services.

Currently, no management plans have been developed for the wetlands within the project area. The modelling work from this project demonstrates the business case for actively managing the wetlands to ensure they continue to provide services indefinitely. By doing so, the Town of Riverview can avoid the capital cost of building, as well as ongoing maintenance and operating costs.

Annual monitoring, operating and maintenance expenditures for both natural assets and engineered alternatives have been approximated for this project and can inform a management plan. Three scenarios represent differing options for the Mill Creek project area. The first scenario assumed development is done in a way that avoids damaging existing wetlands, which currently contribute flood protection and stormwater management services, and some engineered stormwater infrastructure is required to offset the net peak flow impact from development. The second scenario assumed the existing wetlands could be enhanced to achieve the required peak flow offset from development. The final scenario assumed development damages wetlands to the point where their stormwater function is eliminated, resulting in the need for a fully engineered replacement to control stormwater flows. The scenarios were considered for both current and future climate conditions. Specifically, the three scenarios assessed the lifecycle costs [capital + operating and maintenance (O&M) expenditures over 100-year planning horizon] and are defined as follows:

1. Cost **with** development assuming retention ponds are required to offset the increased peak flow associated with the 100-year storm **with** wetlands.
2. Cost **with** development assuming modifications to the existing wetlands can offset the peak flow through restoration and enhancement efforts.
3. Costs **with** development assuming retention ponds are required to offset the increased peak flow associated with the 100-year storm **without** wetlands.

Lifecycle cost considerations are summarized as follows and Table 9 provides a list of key assumptions used to conduct the lifecycle analysis of the three scenarios.

- Riverview Asset Management Plan considers O&M costs over a 100-year period to provide an indication of future cash flow requirements. To align with existing management planning this time span is considered.
- All engineered assets will require replacement or revetment costs at the end of their useful life. Assumed useful life of a constructed retention pond is 25 years. Replacement/revetment cost was assumed to be 50% of the original construction costs.[9]
- Assets are assumed to be replaced with the most appropriate type that provides the same level of service (referred to as 'the optimized replacement cost').
- Natural assets do not have an end of life.
- O&M costs remain consistent (besides inflation) over the planning horizon and are assumed to be 3% of capital costs.[10]
- All future costs are discounted to present values (PV) based on a 3% discount rate.

TABLE 9 - SUMMARY OF ASSUMPTIONS FOR LIFECYCLE COST ANALYSIS

Assumption	Scenario		
	Development maintaining wetlands + smaller engineered ponds	Development maintaining wetlands with added constructed wetland capacity	Development replacing wetlands with stormwater ponds
Required storage (m^3) current climate	12,759	12,759	15,623
Required storage (m^3) future climate	13,614	13,614	16,499
Assumed useful life	Wetlands = Indefinite Ponds = 25 years	Wetlands = Indefinite	Ponds = 25 years
O&M Costs	Engineered = 3% of capital costs Natural = none	Natural = none[11]	Engineered = 3% of capital costs
Capital Costs	Engineered pond to ensure no-net-runoff from development	Constructed changes to wetlands to increase capacity	Engineered pond to ensure no-net-runoff from development

9 These values are rough approximations that are conservative in nature. In reality, the useful life could be longer and the costs lower.

10 Weiss et al. (2005) show that annual O&M costs for a wet retention pond range from 2% to 10% of capital costs. However, the majority of the estimates were below 5% of capital cost. Therefore, 3% is used as an approximate mid-point estimate.

11 This may be an underestimate of operation and maintenance costs. See Ross, Lisette and Dave Martz, 2013 for more information on the cost of naturalized stormwater pond construction and maintenance in relation to traditional stormwater ponds.

Tables 10 and 11 summarize the results of the lifecycle assessment for the 3 scenarios under current and future climate conditions, respectively. Under current climate conditions, the existence of wetlands offsets the present value of lifecycle costs by $1.17 million. These reduced costs are slightly higher under projected future climate conditions with a present value of $1.19 million in avoided costs. However, wetland enhancements could offset the needed peak flow reduction and significantly reduce the lifecycle costs. Constructed wetland costs were used to approximate the capital cost of creating additional wetland capacity.[12] Assuming sufficient capacity could be achieved through wetland enhancement, the analysis suggests roughly $6 million could be saved.

TABLE 10 - LIFECYCLE COSTS FOR INFRASTRUCTURE OPTIONS UNDER CURRENT CLIMATE CONDITIONS

Lifecycle variable	Scenario		
	Development maintaining wetlands + smaller engineered ponds	Development maintaining wetlands with added capacity	Development replacing wetlands with stormwater ponds
Annual O&M Costs	$66,985	None	$82,021
100 year PV* of O&M	$2.12 million	Nil	$2.59 million
100 year PV* of Capital Costs	$3.12 million	$416,000	$3.82 million
Total 100 year PV* cost (O&M + Capital)	$5.24 million	$416,000	$6.41 million

*PV = present value

TABLE 11: LIFECYCLE COSTS FOR INFRASTRUCTURE OPTIONS UNDER FUTURE CLIMATE CONDITIONS

Lifecycle variable	Scenario		
	Development maintaining wetlands + smaller engineered ponds	Development maintaining wetlands with added capacity	Development replacing wetlands with stormwater ponds
Annual O&M Costs	$71,474	None	$86,620
100 year PV of O&M	$2.26 million	nil	$2.74 million
100 year PV of Capital Costs	$3.32 million	$444,000	$4.03 million
Total 100 year PV cost (O&M + Capital)	$5.58 million	$444,000	$6.77 million

12 Weiss et al. (2005) show report a range of cost estimate for constructed wetlands in the US. The report cost per cubic foot ranged depending on the capacity created. The cost for the required capacity in this case was roughly $0.5 per cubic foot, or $32.60 per m^3 after adjusting to 2019 CAD.

Implementation of Natural Asset Plan

SERSC Planning staff presented the MNAI project findings to the Town of Riverview's Chief Administrative Officer, as well as to the Economic Development, Engineering, and Recreation Directors. Agreement was reached to work together with municipal council to modify existing by-laws to work at implementing the project findings.

The *Community Planning Act* provides the mechanism to adopt a secondary plan for a specific area of a municipality. This offers the opportunity to create more a fine-grained land use plan for the Mill Creek project area that will guide future development in a way that capitalizes on natural assets and reduces development costs associated with hard infrastructure.

The *Act* includes other regulations that may also apply to this area, including a development charge regulation that is currently under review province-wide. This regulation will allow municipalities to require developers to pay for the infrastructure and service costs associated with opening new areas to development. SERSC has communicated with the province to emphasize the importance of including natural assets within the scope of this regulation.

SERSC has been working with municipal partners to help them establish GIS-based asset management plans with the help of provincial gas tax funds. The intent of the plans is to add natural assets to their balance sheets at the same time as the mapping of traditional infrastructure assets, such as sewer and water lines. In addition, findings of the MNAI project will also be included in a climate adaptation plan that is currently being developed.

Summary

The focus of the project was a large development area proposed within the Mill Creek Watershed, which is being designed adjacent to a nature park. As is standard practice with MNAI projects, this project included the development of a natural asset inventory, condition assessment, stormwater modelling, economic assessment and initial planning considerations.

The findings demonstrate that the wetlands and surrounding natural areas within the Mill Creek watershed provide valuable storage capacity that if lost, will result in costs to Riverview to meet the regulatory requirements in the stormwater design criteria. These costs increase if future climate conditions are factored in. Project results indicate that the existing wetlands are currently attenuating nearly 19,000 m^3 of total flow over 24 hours. Under climate change conditions, the wetlands contribute an additional 284 m^3 of flow attenuation over a 24 hour period. Modelling also revealed the importance of forest cover in reducing stormwater runoff. When comparing current development scenarios with the proposed development scenarios, the findings reveal that roughly 33,000 - 34,000 m^3 of runoff is controlled by the existing vegetation. Less effective on a per area basis than wetlands, forests also provide a valuable contribution to stormwater management services.

The monetary value of stormwater services provided by the wetlands for a 5-year return period precipitation event was estimated at roughly $1.07 million under current climate. Factoring in future development, increases the estimated cost to $2.30 million and under assumed future climate conditions, the costs increase even further to $2.41 million. The same pattern exists for the 100-year precipitation event. The figures above exclude the range of co-benefits associated with the wetlands in the project area including improvements to water quality, provision of wildlife and aquatic habitat, and health and recreational benefits.

Annual monitoring, operating and maintenance expenditures for both natural assets and an engineered alternative were approximated for this project. Under current climate conditions, the existence of wetlands offsets the present value of lifecycle costs by $1.17 million. These reduced costs are slightly higher under projected future climate conditions with a present value of $1.19 million in avoided costs. However, wetland enhancements could offset the needed peak flow reduction and significantly reduce the lifecycle costs. Constructed wetland costs were used to approximate the capital cost of creating additional wetland capacity.

Currently, no operation and management plans have been developed for the wetlands, however a web-based tool has been created to view the natural asset inventory and condition assessment alongside engineered assets. The tool and the modelling work completed for this project helps build a case for the need to actively manage these wetlands to ensure they continue to provide services indefinitely. By doing so, the Town of Riverview can avoid the capital cost of building engineered alternatives while improving data accessibility for on-going decision-making.

This project was reviewed by the Town and agreement was reached to work with SERSC and municipal council to modify existing by-laws to work at implementing project findings. Relevant policies have been identified and/or are under review. SERSC is also supporting municipal partners to establish GIS-based asset management plans that consider both engineered and natural assets.

Appendix A: Initial engagement session agenda and list of participants

Municipal Natural Assets Initiative (MNAI) – Cohort 1 Launch Workshop

For Southeast Regional Service Commission

May 22-23 2018 - 0800-1830

Location:

Draft Annotated Agenda

Meeting purpose

Launch MNAI project.

Objectives

1. Ensure common understanding of: MNAI method, process & milestones; project details; roles, responsibilities and expectations
2. Develop detailed roadmap towards Milestone 1, including understanding of roles and responsibilities

Anticipated outputs

1. Final project document (although some details may continue to evolve)
2. Roadmap towards Milestone 1* including specific dates and times for regular check-ins and product deadlines.
3. Description of next steps

Meeting documents (available at https://tinyurl.com/y8ynjjvu)

- Signed MOU
- Project document
- MNAI introductory presentation
- MNAI presentation on data needs and collection
- Enlarged maps of site (provided by local government)
- Workplan template (to fill out at end of meeting)
- MNAI Communications plan
- *Note on Milestone 1
- Milestone 1 needs to be reached by Week 1 of September 2018.
- The Milestone is: Creating foundation: biophysical characteristics and condition of municipal natural assets are understood and documented, all data is gathered.
- Milestone 1 webinar will occur in first 2 weeks of September with objective of extracting and sharing key lessons or findings from data gathering (e.g. are there particular challenges or opportunities in terms of finding good data, and lessons that can be shared.
- MNAI team will provide help desk support between launch workshop and Milestone 1 webinar to make sure Milestone is reached.

AGENDA			
Time	**Item**	**Lead**	**Outcome & Comments**
RIVERVIEW, NB			
Part 1: Creating a common understanding			
0800-0815	Welcome and introductions	Local government	
0815-0845	Overview of MNAI process: how we got here and what to expect	Roy	Objective: ensure participants understand have shared understanding of MNAI and what to expect
0845-1000	Overview of project document: goals, objectives, outputs of project	Local government with Michelle and Jeff	Objective: ensure common understanding of project
1000-1015	Break		
1015-1115	Introduction to goals, objectives and activities towards Milestone 1	Michelle & Jeff	Objective: ensure common understanding of what is required for effective data gathering to meet project goals
1115-1215	Discussion on roles and responsibilities towards Milestone 1	Michelle & Jeff with support from Roy	
12h15-13h30	Conclusions, next steps	Roy, Michelle, Jeff	[This part can be shortened or used to cover additional issues raised during the day]
1330-1400	Working Lunch	All	Discussion: did the site visit change anyone's understanding of the project? Lunch provided by local government

Participants:

James Bornemann – Geomatics Analyst – South East Regional Service Commission

Colin Smith – Chief Administrative Officer, Town of Riverview

Shane Thomson – Director of Ecnonomic Development, Town of Riverview

Gerry Cole – Director of Parks, Recreation and Community Relations, Town of Riverview

Robert Higson – Treasurer, Town of Riverview

Michel Ouellet – Town Project Manager, Town of RIverview

Guillaume Fortin, Université de Moncton professor

Francis Thériault – Université de Moncton Masters student and intern with SERSC

Daniel DeLong – Friends of Mill Creek

Phil Robichaud – Development officer and Engineer-in-Training, Southeast Regional Service Commission

Sébastien Doiron – Planning Director, Southeast Regional Service Commission

Marc Leger – Regional Trails Coordinator, Southeast Regional Service Commission

Tyler Searls – GIS support, Southeast Regional Service Commission

Eric Hopper – Manager of Recreation Facilities & Assets, Town of Riverview

Roy Brooke – Executive Director, MNAI

Michelle Molnar – Technical Director, MNAI

Jeff Wilson – Technical Support, MNAI

Josh Thiessen – Technical Support, MNAI

References

Adameus, P. 2018. Chapter 4.3.2 – WEST (Wetland Ecosystem Services Protocol): A suite of regionalized RAMs. https://doi.org/10.1016/B978-0-12-805091-0.00011-6.

Ducks Unlimited. 2018. Wetland Ecosystems Protocol Services Assessment on Four Riverview Wetlands for Municipal Natural Assets Initiative.

Euliss, N.H. Jr.; Gleason, R.A.; Olness, A.; McDougal, R.L.; Murkin, H.R.; Robarts, R.D.; Bourbonniere, R.A.; & Warner, B.G. 2006. North American Prairie Wetlands are Important Nonforested Land-Based Carbon Storage Sites. The Science of the total environment. 361. 179-88. 10.1016/j.scitotenv.2005.06.007.

GEMTEC Limited. 2012. "DRAFT – Condition Assessment Mill Creek Dam. Prepared for Town of Riverview.

J. D. Irving. 2014. The 2012-21 Forest Management Plan for Crown License 7. Available at: https://www.jdirving.com/uploadedFiles/Sustainability/Environment/New_Brunswick_Crown_Timber_License/Crown%20License%206_7%20Management%20Plan%20(Detailed%20Report).pdf.

MNAI. 2017. Defining and Scoping Municipal Natural Assets. Available at: https://mnai.ca/key-documents/.

New Brunswick Department of Environment and Local Government. 2016. Manual for Wetland Ecosystem Services Protocol for Atlantic Canada (WESP-AC): Version 1.2.1. Non-tidal Wetlands.

Ross. L. and Martz, D. 2013. Integrating natural wetlands and improving design of naturalized stormwater management facilities in the City of Edmonton: Workshop Guide. Available at: https://www.edmonton.ca/city_government/documents/PDF/Wetlands_Stormwater_Workshop_Guidebook.pdf.

Sahl, J., Hamel, P., Molnar, M., Thompson, M., Zawadzki, A. and Plummer, B. (2016). Economic Valuation of the stormwater management services provided by the Whitetower Park ponds, Gibsons, BC.

Town of Riverview. 2011. Storm water design criteria manual.

Town of Riverview. 2013. Mill Creek Nature Park: Development Master Plan 2013.