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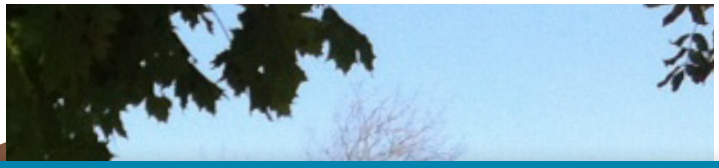

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Toward natural asset management in the

Municipality of the District of Lunenburg

Nova Scotia

Summary of inventory results and implications
April 2021

This document features interactive elements! Clicking on a heading or sub-heading in the Table of Contents (ToC) will take you directly to that page. Also, clicking on page numbers in the footer will bring you back to the ToC.

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Municipal Natural Assets Initiative

MNAI.CA
Making Nature Count

Invest in Nature

The Municipal Natural Assets Initiative (MNAI) is a Canadian not-for-profit that 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.

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Table of Contents

1 Purpose

This document summarizes the results of a project to develop a natural asset inventory in the Municipality of the District of Lunenburg, and documents steps the local government can take to proceed to a full natural asset management initiative.

2 Introduction

What are municipal natural assets

The term *municipal natural assets* refers to the stock of natural resources or ecosystems that a municipality, regional district, or other form of local government could rely upon or manage for the sustainable provision of one or more local government services[1].

Why manage natural assets

A growing number of local governments recognize that it is as important to understand, measure, manage and account for natural assets as it is for engineered ones. Doing so can enable local governments to provide *core* services such as stormwater management, water filtration, and protection from flooding and erosion, as well as *additional* services such as those related to recreation, health and culture. Outcomes of what is becoming known as *municipal natural asset management* can include cost-effective and reliable delivery of services, support for climate change adaptation and mitigation, and enhanced biodiversity.

How to manage natural assets

There are numerous ways for local governments to manage natural assets. The Municipal Natural Assets Initiative (MNAI) uses methodologies and tools rooted in standard asset management, and provides a range of advisory services to help local governments implement them. MNAI has developed the methods and tools with significant investments, piloting, refinement, peer review, and documentation of lessons in multiple Canadian provinces. MNAI's mission is to make natural asset management a mainstream practice across Canada, and in support of this, for local governments to accept and use the methodologies and tools in standard ways across the country.

1 *mnai.ca/media/2018/02/finaldesignedsept18mnai.pdf*

What is a natural asset inventory

Inventories provide details on the type of natural assets a local government relies upon[2], their condition, and the risks they face. As depicted in Figure 1 and explained in detail in the Annex, a natural asset inventory is the first component of the Assessment phase. The Assessment phase, in turn, is the first of three phases of a full natural asset management project. By itself, an inventory will not give a sense of asset value, but is an essential first step in the full natural asset management project.

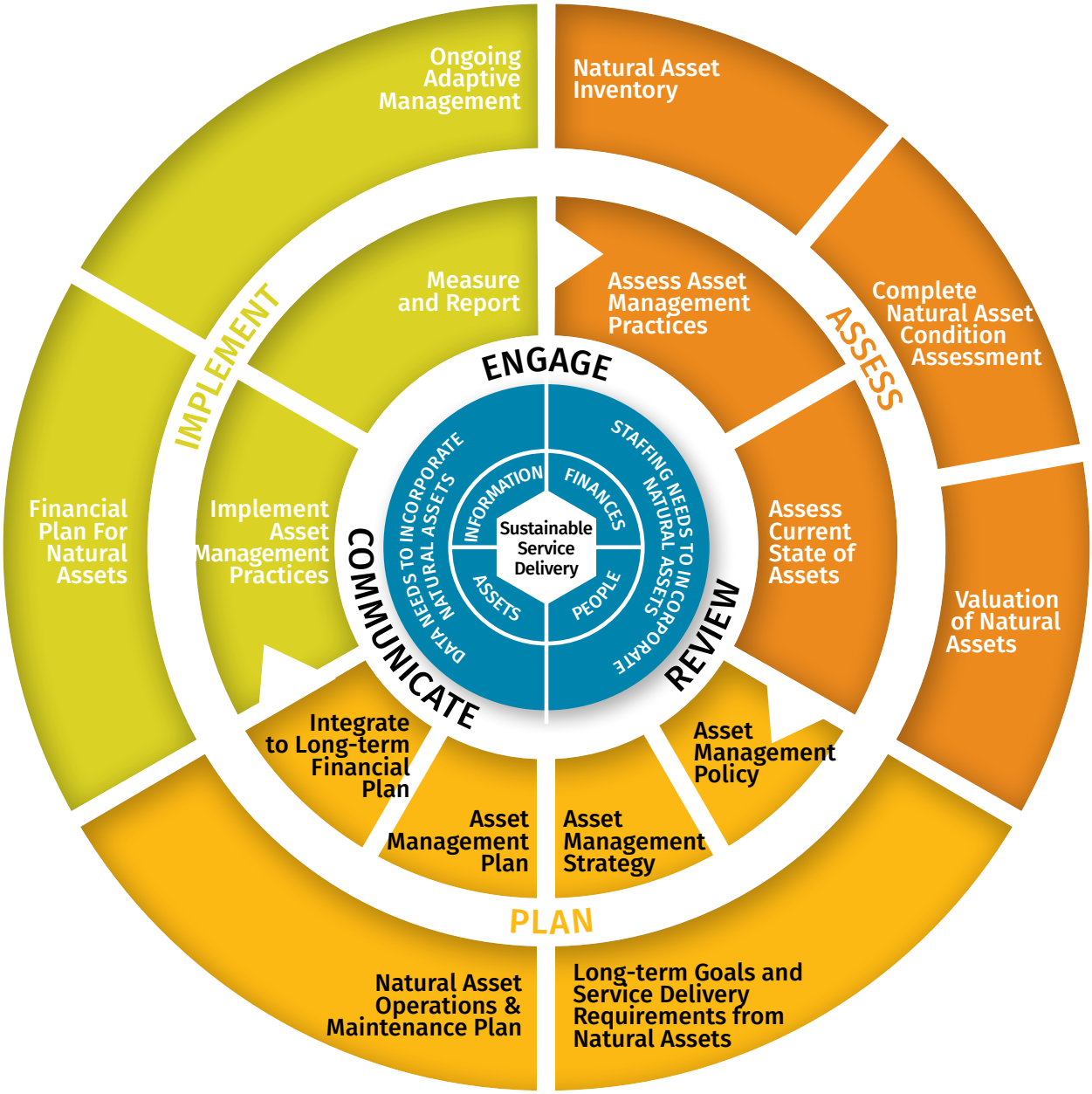

Figure 1: *The Asset Management Process. MNAI has adapted this for use with natural assets.*

2 *Note that many local governments rely on services from natural assets they do not own.*

3 Local government context

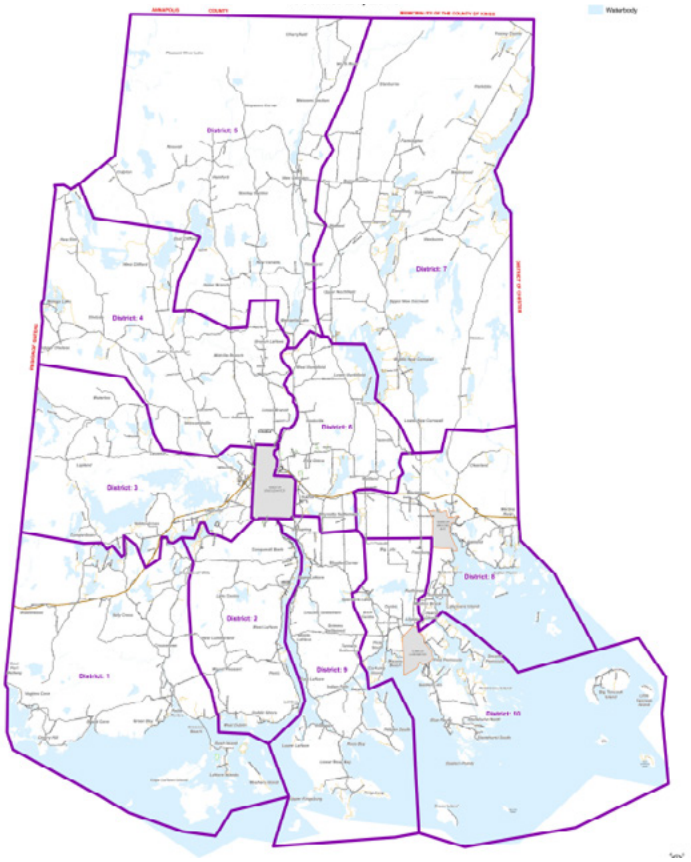

Figure 2: Municipality of the District of Lunenburg[3].

The Municipality of the District of Lunenburg (MODL - population ~25,000) is a district municipality in Lunenburg County, Nova Scotia.

MODL has three main interests in natural asset management. First, it wants a better understanding of the natural assets upon which it relies. This will ensure they take natural assets into account in future projects and policies, and helps focus efforts on their preservation. Second, MODL would like information regarding the role of natural assets to support infrastructure renewal. In this context, MODL plans to use inventory results to support asset management planning and the current capital assets plan. Third, MODL wants to ensure the inventory supports other plans and processes. For example, it could enhance MODL's current land use planning and by-laws, improve planning strategies, and guide Minimum Land Use planning.

MODL faces several climate-related risks such as a longer and more intense hurricane period leading to coastal and inland flooding, as well as more coastal erosion. An increase in the number of hot days and higher temperatures are forecast. This, combined with less frequent rain, could lead to drought and increase forest fire frequency. Thus, flood mitigation, drinking water provision and purification, drought and stormwater management are high priority services of concern. An update to the Local Climate Change Action Plan (LCCAP) is underway through the Partners for Climate Protection Program (PCP) with a focus on mitigation and adaptation.

In general terms, healthy forested areas, grasslands, shrublands and wetlands can absorb and store water, which in turn may result in improved surface water quality, aquifer recharge and stormwater management. As well, intact coastal dunes can mitigate the impacts of waves and sea level rise, thus reducing inland flooding. More specifically, MODL has three watersheds that provide drinking water to the population through municipal water supply or individual wells. MODL also benefits from the stormwater runoff and overland flooding

3 *Retrieved March 4, 2021 from www.modl.ca/district-maps.html#:~:text=The%20Municipality%20of%20the%20District%20of%20Lunenburg%20is,Deputy%20Mayor%20is%20elected%20by%20their%20fellow%20Councillors.*

protection that these watersheds provide. During intense storm periods, these areas act as a first defense by storing and later cleaning water from stormwater runoff and overland flooding. Without these areas, MODL would have to invest significantly in water treatment and flooding protection. This inventory will enable MODL to identify assets that have increased resistance to drought or help alleviate drought. It can also help ensure that the drought resistance strategy accurately values these natural assets and supports their protection and enhancement.

MODL has some protected natural areas such as lakes and watershed areas as part of its current land use by-laws. Its open space strategy also supports the acquisition of ecologically sensitive land by the municipality for conservation. While natural assets are not currently part of MODL's asset management plan and are currently conceptualized and managed primarily in terms of recreational services, MODL believes they fit the criteria to be considered tangible capital assets under their current policy.

3.2. Asset management readiness assessment

As part of inventory development, MNAI helps local governments determine their overall state of asset management maturity.

To do this, MNAI adapted the Federation of Canadian Municipalities (FCM)'s asset management readiness assessment tool to include natural asset considerations. The adapted tool helps local governments measure progress on asset management generally, and natural asset management specifically, in four competency areas. Each competency area describes outcomes based on five levels of progress or maturity.

The completed assessment will, in turn, help the local government prioritize actions that will increase its effectiveness in managing all assets, including natural ones.

See *fcm.ca/sites/default/files/documents/resources/tool/asset-management-readiness-scale-mamp.pdf* for details.

The assessment results indicate MODL is at an early stage of adoption of asset management for both engineered assets and natural assets. While MODL recognizes the importance of natural assets, its asset management policy does not specifically reference them. Natural assets help prevent floods, filter water, control erosion and absorb carbon dioxide (CO_2), all of which contribute to MODL's Climate Change Plan objectives. MODL has a supportive policy in place to purchase, and has purchased, some natural assets and greenspaces such as woodlots and wetlands in order to conserve them.

MODL has identified a cross-functional team responsible for asset management and there is an asset management champion, but roles and responsibilities of the team have yet to be defined. Specific resources have not been committed to natural asset management yet.

With the completion of the natural asset inventory, MODL now has basic pooled inventory data for both engineered and natural assets, but has limited information about levels of service or performance of assets. Its asset investment plans and capital budgets focus on engineered infrastructure assets but the budgets do include maintenance for some green infrastructure such as roadsides, ditches, and recreation areas including forests and walking paths.

4 Natural asset inventory

4.1. Inventory overview

MNAI gathered a range of data for an area scoped to the MODL municipal boundary. The inventory has two main components to express the information: an asset registry and an online dashboard. MNAI provided the registry to MODL as Excel data, and the dashboard in a website format. Information on the condition of the assets is a subset of the inventory and is depicted in both the registry and dashboard.

4.2. Inventory data

MNAI used a number of data layers that MODL provided and combined the spatial data to establish a comprehensive depiction of natural assets. Table 1 describes the data sources used to develop the inventory and condition assessment.

TABLE 1: DATA SOURCES SUMMARY

DATA	SOURCE	PURPOSE
Wetlands2021.shp	Nova Scotia Interpreted Forest Inventory - Current Forest Data	Municipality of the District of Lunenburg
NS_Parks_and_Protected_Areas	Nova Scotia Protected Areas System	Province of Nova Scotia
lunsig	The Significant Species and Habitats (Sighab) Database	NS Department of Natural Resources Significant Species and Habitats
Municipality and Village Boundaries	Municipality and Village Boundaries	Province of Nova Scotia
Nova Scotia Community Boundaries (NSCAF)	Nova Scotia Community Boundaries (NSCAF)	Province of Nova Scotia
Crown_Lands	Crown Lands	Province of Nova Scotia
AgSuitabilityMODLWeightOverlay.tif	Agriculture Suitability Weighted Overlay	Municipality of the District of Lunenburg
FederalLandCapability.shp	Federal Land Capability	Federal
GovLands2020.shp	Government Lands	Municipality of the District of Lunenburg

TABLE 1: DATA SOURCES SUMMARY

DATA	SOURCE	PURPOSE
lunemtm_Soils.shp	Lunenburg Soils	Municipality of the District of Lunenburg
ProtectedBeachesDNR.shp	Protected Beaches DNR	Municipality of the District of Lunenburg
Surficial_Geology_Classes.shp	Surficial Geology Classes	Municipality of the District of Lunenburg
Waterbody.shp	Waterbody	Municipality of the District of Lunenburg
WaterSupply_DaresLake.shp	Water Supply Dares Lake	Municipality of the District of Lunenburg
WaterSupply_Oakland.shp	Water Supply Oakland	Municipality of the District of Lunenburg
WaterSupply_PetiteRiviere.shp	Water Supply Petite Riviere	Municipality of the District of Lunenburg
WellLogs2010additional.shp	Well Logs	Municipality of the District of Lunenburg
RoadCentreline.shp	Roads	Municipality of the District of Lunenburg
Global Man-made Impervious Surfaces Dataset	Informed the condition assessment	NASA *data.nasa.gov/dataset/Global-Man-made-Impervious-Surface-GMIS-Dataset-Fr/dkf4-4bi3*

The inventory project defined a total of 42,578 individual assets, covering 178,753 hectares (ha), as noted in Table 2. The majority of this was forest cover, followed by inland water.

TABLE 2: SUMMARY OF NATURAL ASSETS BY TYPE

NATURAL ASSET TYPE	NUMBER OF ASSETS	TOTAL AREA (HA)	AVERAGE ASSET AREA (HA)
Agriculture	1,403	7,048	5.02
Beach	85	160	1.89
Cliffs, Dunes, Coastal	628	492	0.78
Forest	34,044	148,192	4.35
Grassland	284	508	1.79
Inland Water	1,340	11,565	8.63
Ocean Wetland	8	0.31	0.04
Open Space and Successional	245	118	0.48
Shrubland	482	610	1.27
Wetland	4,059	10,060	2.48
Total	**42,578**	**178,753**	**4.20**

4.3. Asset registry

MNAI gathered the data, sorted and analyzed it for relevance, and then delineated the type, location and extent of natural assets within the project area. Each asset has a unique identification number that allows individual assets to be selected, analyzed, and the corresponding data manipulated as required. For example, changes in condition can be noted for individual assets. The information pertaining to each asset was then placed into an asset registry. An excerpt from MODL's registry showing natural asset characteristics and details is in Table 3.

TABLE 3: EXCERPT FROM THE REGISTRY

Natural Asset Registry

Asset ID	Asset Type	Asset Area (ha)	Sub Asset Area (ha)	Neighbourhood	Main Species Type	Significant Habitat	Water Supply	Majority Topography	Majority Soil Type	Majority Land Capability	Interior Forest %	Government Lands Area (ha)	Permeability Score	Adjacent Land Use Score	Road Density Score	Relative Size Score	Total Score
AGR100	Agriculture	13.37	13.37	Stanburne	Not Applicable			Flat to rolling, with many surface boulders	Wolfville Stony Loam	7	0	0.00	5	8	5	5	23
AGR1000	Agriculture	2.58	2.58	Upper Chelsea	Not Applicable			Drumlins often with multiple tills	Bridgewater Loam - Drumlin Phase	7	0	0.00	5	7	5	1	18
AGR1001	Agriculture	0.03	0.03	Upper Chelsea	Not Applicable			Flat to strongly rolling; ridges of hard rock exposed in thintill areas	Bridgewater Loam - Drumlin Phase	7	0	0.00	5	6	5	1	17
AGR1002	Agriculture	12.89	12.89	Upper Chelsea	Not Applicable			Drumlins often with multiple tills	Bridgewater Loam - Drumlin Phase	7	0	0.00	5	8	5	5	23
AGR1003	Agriculture	2.56	2.56	Waterloo	Not Applicable			Flat to strongly rolling; ridges of hard rock exposed in thintill areas	Bridgewater Sandy Loam	7	0	0.00	5	9	10	1	25
AGR1004	Agriculture	21.15	21.15	Waterloo	Not Applicable			Flat to strongly rolling; ridges of hard rock exposed in thintill areas	Bridgewater Loam - Drumlin Phase	7	0	0.00	5	8	1	10	24
AGR1005	Agriculture	10.40	10.40	Waterloo	Not Applicable			Drumlins often with multiple tills	Bridgewater Loam - Drumlin Phase	7	0	0.00	5	8	5	5	23
AGR1006	Agriculture	7.83	7.83	Waterloo	Not Applicable			Drumlins often with multiple tills	Bridgewater Loam - Drumlin Phase	7	0	0.00	5	7	1	5	18
AGR1007	Agriculture	12.40	12.40	Waterloo	Not Applicable			Drumlins often with multiple tills	Bridgewater Sandy Loam	7	0	0.00	5	8	5	5	23
AGR1008	Agriculture	24.50	24.50	Waterloo	Not Applicable			Drumlins often with multiple tills	Bridgewater Sandy Loam	7	0	0.00	5	8	5	10	28
AGR1009	Agriculture	2.09	2.09	Laconia	Not Applicable			Drumlins often with multiple tills	Bridgewater Loam - Drumlin Phase	7	0	0.00	5	9	10	1	25
AGR101	Agriculture	0.75	0.75	Stanburne	Not Applicable			Flat to rolliing, few surface boulders; till is thick enough to mask bedrock undulations	Wolfville Sandy Loam - Drumlin Phase	7	0	0.00	5	9	10	1	25
AGR1010	Agriculture	5.51	5.51	Laconia	Not Applicable			Drumlins often with multiple tills	Bridgewater Loam - Drumlin Phase	7	0	0.00	5	9	10	1	25
AGR1011	Agriculture	1.45	1.45	Laconia	Not Applicable			Drumlins often with multiple tills	Bridgewater Loam - Drumlin Phase	7	0	0.00	5	9	10	1	25
Total			**178,786.95**														

4.4. Online dashboard

Inventories may provide more insights when characterised visually in a dashboard, which enables users to explore different aspects of the data. For instance, natural asset information can be quickly summarized by watershed area, or, if users want to dive into the specifics of forest assets, they can quickly filter the data to focus on that particular asset. Figure 3 and Figure 4 are screen shots from the dashboard that MNAI provided to MODL. The full version can be accessed at *https://go.greenanalytics.ca/Lunenburg*.

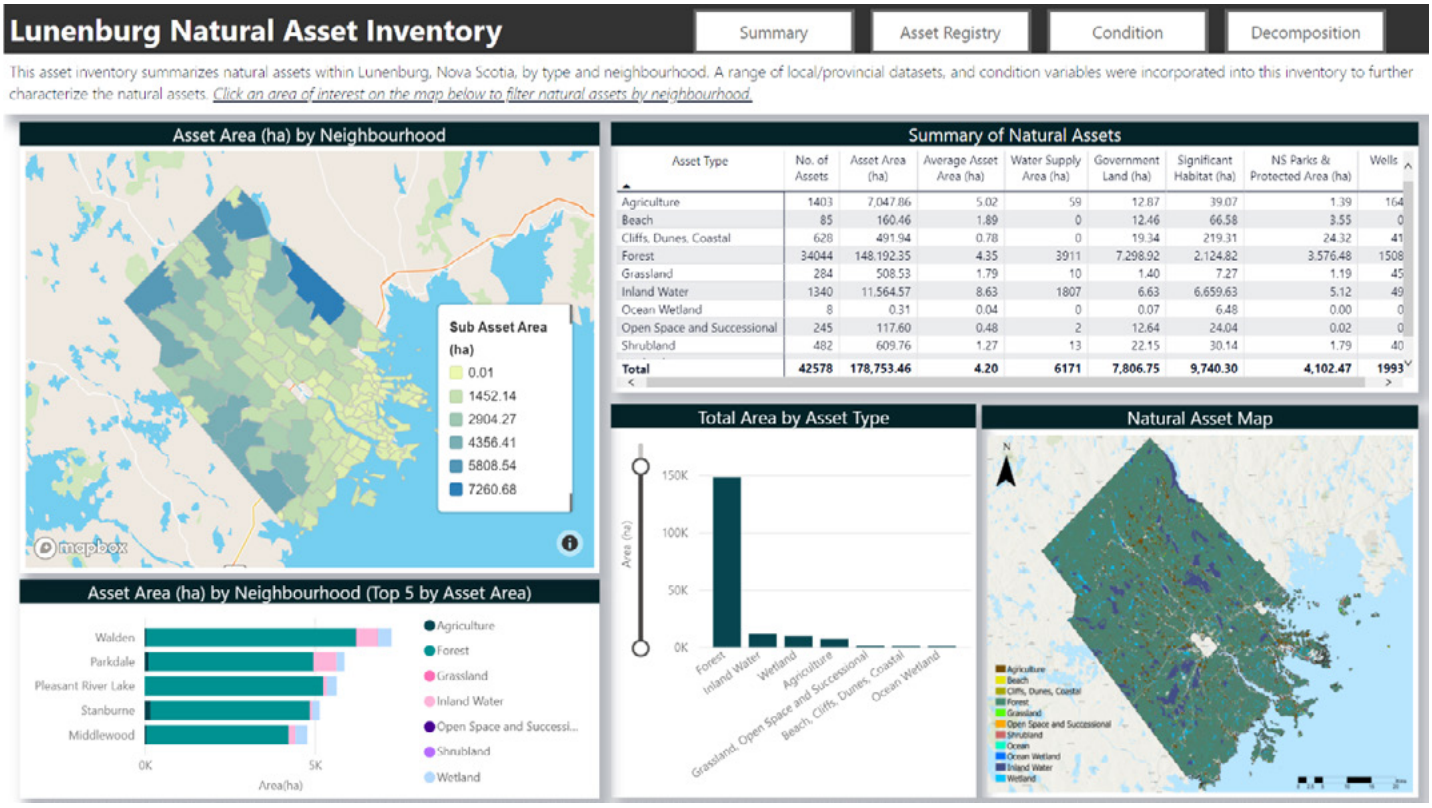

Figure 3: Screenshot of main inventory summary

4.5. Condition of natural assets

Documenting the condition of natural assets is a key aspect of natural asset inventories. A natural asset condition assessment provides an understanding of both the ecological health of natural assets, and the ability of natural assets to provide services. This information, in turn, can support the effective management of natural assets, be reflected in the registry and the dashboard, and updated over time.

MNAI completed a desktop condition assessment and built it into the inventory to provide an initial understanding of the status of the natural assets for the municipality. Table 4 summarizes the condition assessment steps and indicators.

TABLE 4: CONDITION ASSESSMENT APPROACH AND INDICATORS

Indicator	Description & Methods for Quantification	Data used to Quantify Indicator
Relative asset size	For each natural and semi-natural asset type, total area is calculated and a rank is assigned to the assets within each class based on its percentile score. Natural assets within the top third of the ranking (e.g., the largest assets within a class) received a 3, those within the middle third of the ranking received a 2, and those within the bottom third of the ranking received a 1.	Natural asset inventory
Road density	Measures the density of the roads in and around the assets according to high density (assets with more than 2km of roads per square km), medium density (assets with between 1km and 2km of roads per square km), and low density (assets with less than 1km of roads per square km).	Natural asset inventory plus spatial representations of roads.
Surface permeability	The permeability of surfaces is ranked on a scale of nil to high depending on the type of landcover present. Urban areas, roads and industrial areas are ranked as nil. Assets within impervious surfaces are assigned as low permeability. Agriculture and shrublands are ranked as medium. Wetlands, waterbodies and forests are ranked as high.	Natural asset inventory, spatial representations of land uses and roads, as well as the Global Man-made Impervious Surfaces Dataset from NASA. *data.nasa.gov/dataset/Global-Man-made-Impervious-Surface-GMIS-Dataset-Fr/dkf4-4bi3*
Adjacent land use ('nearest neighbours')	Considers the distance to, and the nature of, the area surrounding natural assets. Intense land uses (e.g., airports) in close proximity to natural assets result in a poor rating, while distant land uses that are less intense (e.g., agriculture) result in a good rating.	Natural asset inventory plus spatial representation of land use as well as intensity rankings of land uses.

Once conditions were allocated to each asset, an overall score was derived for the project area. The maximum possible score for an asset was 40, based on a possible 10 points for each of 4 categories:

- Road density rated as either low (10), medium (5) or high (1).
- Surface permeability rated as high (10), medium (5), low (1), or nil (0).
- Adjacent intensive land use (0 for intense land uses, otherwise 10).
- Relative asset size where the largest 3rd areas receive 10, 5 for middle 3rd, and 1 point for the lowest 3rd.

The total condition score was then converted into a rating scale:

- **Good -** assets with a score of 30 or higher
- **Fair -** assets with a score between 20 to 29
- **Poor -** assets with a score between 10 to 19
- **Very Poor -** assets with a score lower than 10

Figure 4 is a snapshot of the results of MODL's condition assessment.

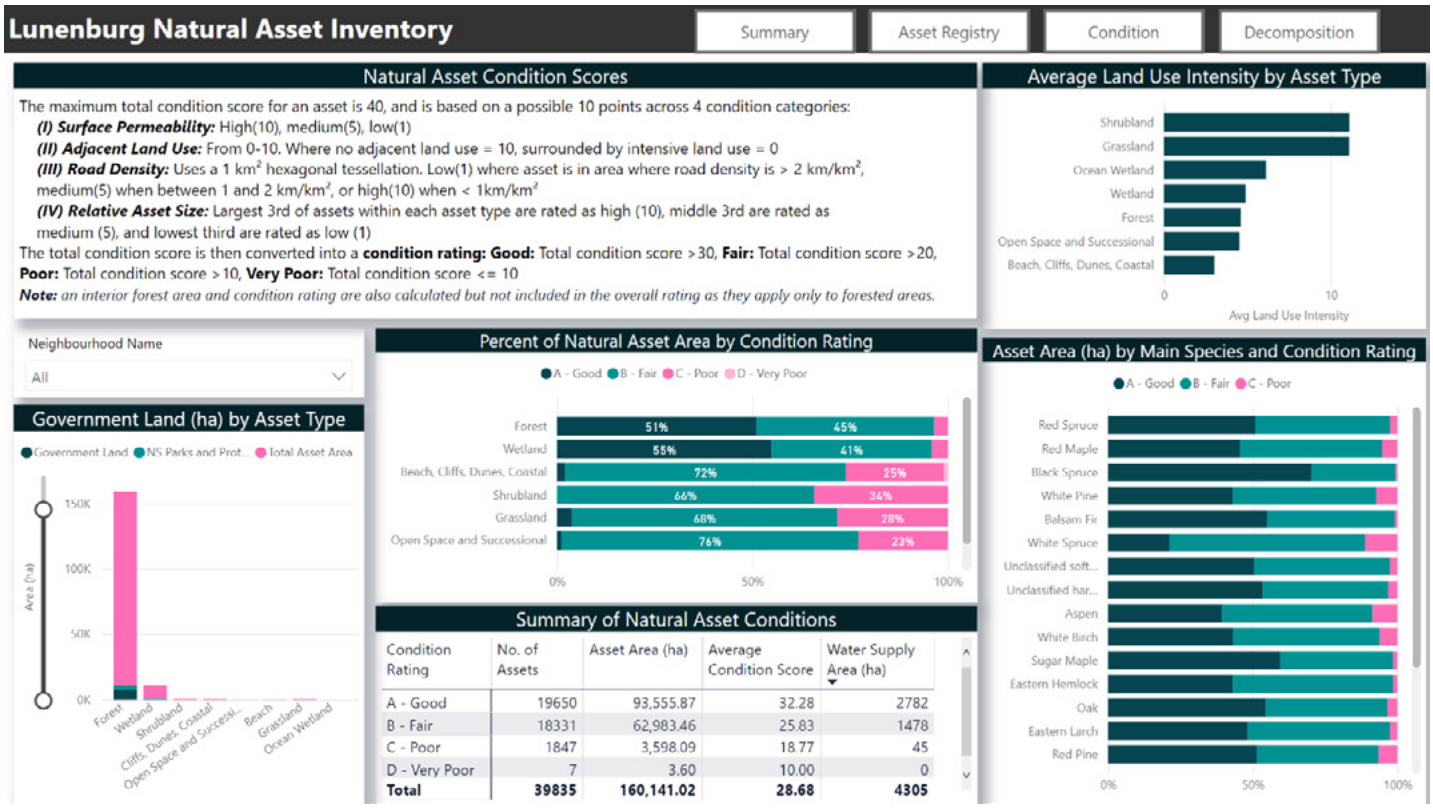

Figure 4: Screenshot of condition assessment results

Overall, about 93,556 ha (or 58 per cent) of natural assets were assessed in good condition and 62,983 ha (or 39 per cent) were assessed in fair condition.

The forest and wetland assets are generally in good or fair condition. The forest and wetland assets in poor condition are due to being small with relatively higher road density.

Table 5 summarizes the condition ratings and Figure 6 summarizes condition by natural asset type.

TABLE 5: SUMMARY OF NATURAL ASSET CONDITION RATINGS			
Condition Rating	**Number of Assets**	**Total Area (ha)**	**Average Total Score**
Good	19,650	93,556	32.28
Fair	18,331	62,983	25.83
Poor	1,847	3,598	18.77
Very Poor	7	4	10.00
Total	**39,835**	**160,141**	**26.68**

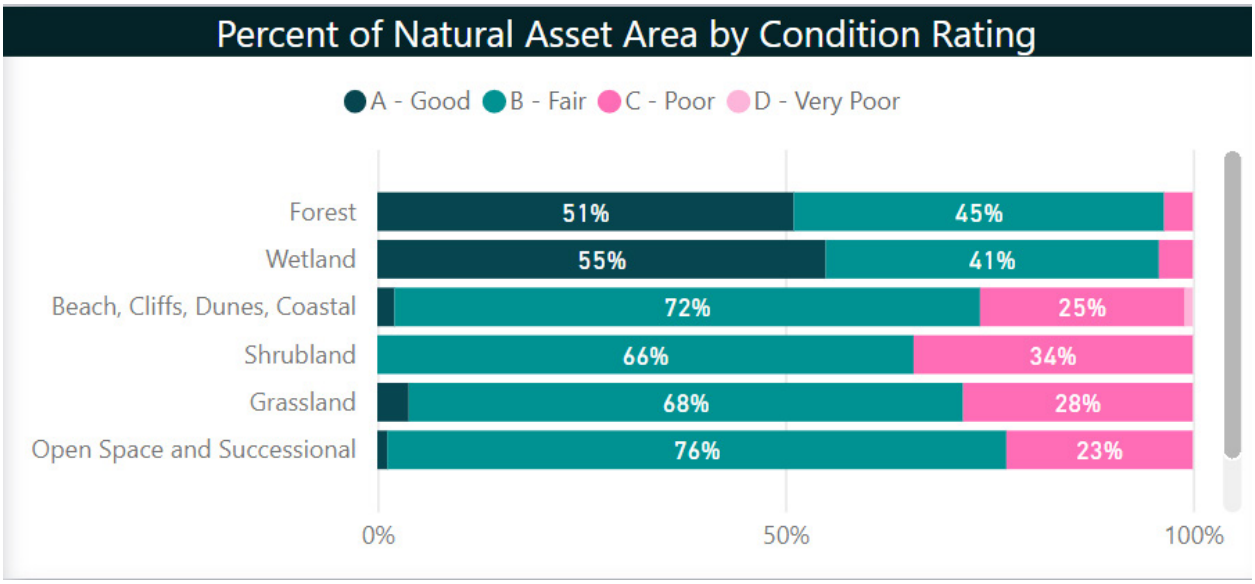

Figure 5: *Summary of condition rating by natural asset type*

4.6. Maintaining the inventory

Inventories are not static. Both the registry and the dashboard can be expanded as new information becomes available. For example, asset condition might improve as a result of restoration efforts, or new studies may add insights on the condition of the assets. New data can be reflected in the asset registry and subsequently in the online dashboard as it becomes available. Furthermore, the level of desired detail may evolve as asset management readiness increases, or as areas of natural management focus emerge. However, inventories should grow in detail and sophistication only insofar as they remain aligned with the capacity of the communities to maintain them, and the uses to which they will be put. Their evolution and development should be a function of the monitoring, reporting and lessons of the asset management cycle and be driven by the imperative of ensuring sustainable, cost-effective delivery of services to the community, which is the core of asset management.

5 Risk identification

5.1. Risk identification tool overview

Identifying risks facing natural assets can help local governments prioritize their management of natural assets. To this end, MNAI provides local governments with a tool entitled *Risk Identification Process in the Development of Natural Asset Inventories* and guidance in self-administering it.

Risk management is a four-stage process that includes risk identification, analysis of probability and consequence, development of risk mitigation strategies, and control and documentation. The use of the risk identification tool informs the first and second stages of risk management through the identification of top risks to natural assets and their associated services, and a high-level analysis of impacts and consequences.

Risk types relevant to natural asset management typically include:

- **Service risk:** the risk of an asset failure that directly affects service delivery.
- **Strategic risk:** the risk of an event occurring that impacts the ability to achieve organizational goals.
- **Operations and maintenance risk:** risks related to poor asset controls and oversight, which can lead to poor record-keeping and poor monitoring of asset.
- **Financial risk:** risks related to the financial capacity of MODL to maintain municipal services.
- **Political risk:** risks related to the nature of municipal politics.

5.2. Using the risk identification tool

Using the risk tool, MODL considered possible risks that the loss of natural asset functions could pose to engineered infrastructure, personal health and safety, and private property, including:

- Coastal flooding (current and future)
- Forest fire
- Invasive species
- Development pressure
- Drought (current and future)
- Erosion
- Ice jams
- Storm surges
- Hurricanes

Each risk was then ranked low, medium or high according to the probability of an impact occurring, and the relative magnitude of its negative consequences. To assess impact and consequence, MODL considered four questions:

1/ what impact is likely to happen?

2/ what is the consequence of that impact happening?

3/ what can be done to mitigate the impact probability and/or consequence?

4/ what cues will signal the need for mitigation?

5.3. Results of the risk identification process

The risk identification process revealed:

- 6 high-level risks (coastal flooding, forest fire, invasive species, drought, development pressure, and hurricanes)
- 2 medium-level risks (erosion and storm surge)
- 1 low-level risk (ice jams)

In terms of scope, the identified risks affect natural assets across the entire area, including inland waters, coastal wetlands, beaches, inland wetlands, cliffs, dunes, forest, grassland, and shrubland.

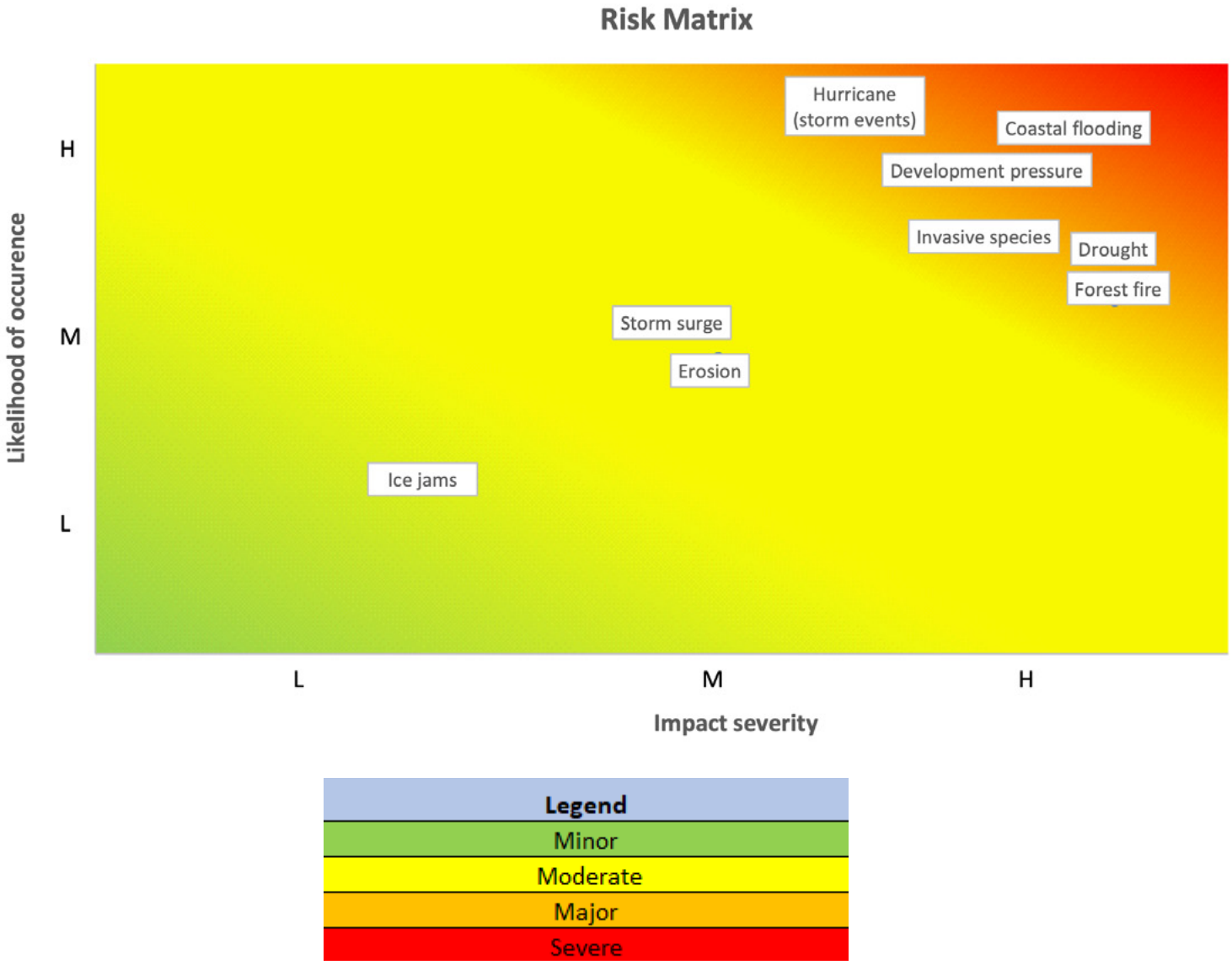

Figure 6: Results of risk management process

6 Implications

This section provides insights that can be gained from considering both the inventory - including the condition and risk assessments - and the asset management readiness assessment. It is divided into (a) potential priorities for the local government (b) possible actions for the further development of the inventory, and (c) steps the local government can consider to advance to a full natural asset management initiative.

6.1. Potential priorities for the local government

Combining the results of the condition assessment with the outcomes of the risk identification highlights potential priorities for MODL to focus their natural asset management efforts. These are:

- **Coastal flooding:** Elevated water levels from the combination of high tides and storm surges can cause coastal flooding and damage dunes, cliffs, beaches, coastal wetlands, beach infrastructure, coastal properties, and roadways. Hurricanes in 1996, 2003, 2007, and 2009 caused significant damage to coastal areas[4]. Upstream flooding can also occur. Flood mapping was completed in 2014 for the LaHave River that considered both fluvial and coastal flooding, which identified areas downstream of Bridgewater as vulnerable to storm surge and sea-level rise[5]. The study did not consider adaptation measures, as it was out of scope, but would be an advisable step.
- **Forest fire:** The majority of MODL's forests, grasslands, and shrublands are in good or fair condition. However, those that are degraded and in close proximity to areas of intense land uses may require heightened attention due to the prevalence of human-caused fires. Furthermore, hotter, dryer summers are projected for the region, bringing greater susceptibility to fire. At this time, however, the Municipal Funding Agreement does not stipulate the provision of capital funds for investment in local fire protection as an eligible expense.[6]
- **Invasive species:** MODL has identified a number of terrestrial and aquatic invasive species in the region, including green crabs, Asian long-horned beetles, spruce bud worm, purple loosestrife, and hogweed. All of these can impact natural assets. The region has also seen an increase in ticks, which can lead to a greater prevalence of tick-borne diseases. Public education campaigns, such as the Nova Scotia Invasive Species Council (*http://nsinvasives.ca*), are an important component of a mitigation strategy.

4 *Taylor et al., 2008.*

5 *Municipality of the District of Lunenburg, 2014.*

6 *Municipality of the District of Lunenburg, 2013.*

- **Drought:** Drought has been identified as a risk to all natural assets. Warmer summers and dry soils can lower water levels in wetlands, creeks, and streams, and also contribute to the loss of trees and fish habitat, threaten species, and increase disease outbreaks. Decreasing water levels may also stress MODL's water supply. Water quantity monitoring can identify when trendlines become serious enough to require the development of drought management plans.
- **Development pressure:** Development pressure can impact MODL's inland water, forests, and wetlands through pollutant loading, eutrophication, algae blooms, sedimentation of waterways, loss of habitat and water retention. MODL has prepared a Comprehensive Community Plan, which is currently available for review. Once finalized, it will guide the Municipal Planning Strategy and land use bylaws[7].
- **Hurricanes:** MODL completed a Climate Hazard Threat Analysis for the 2013 Climate Action Plan, which ranked hurricanes as the highest threat to the region[8]. The damaging winds, storm surges, forest knockdown, fire, erosion, and flooding associated with hurricanes have the potential to impact all natural assets and can bring catastrophic loss to property, infrastructure, and community health and safety. Low-lying areas prone to flooding are at particular risk. In response to this risk, MODL and the Regional Emergency Management Organization has a Hurricane Contingency Plan. The Plan has acknowledged the crucial role of utilities in a response plan and identified this as an information gap and important next step[9].

TABLE 6: RISK MITIGATION STRATEGIES

Accept	Risk may be acceptable if probability and consequences are small
Minimize	Risk under local government's control that warrants exposure reduction
Share	Partners in a project permit the sharing of larger risks to reduce it for each
Transfer	Insurance, fixed price contracts, and other risk transfer tools

Table 6 lists and provides brief descriptions of risk mitigation strategies.

Opportunities to strengthen natural asset management at an organization-wide level

Being at an early stage of adoption of asset management for both engineered infrastructure assets and natural assets presents MODL with the opportunity to ensure that natural asset management objectives are considered in all competency areas. MODL has identified a cross-functional team that should be

7 *Town of Lunenburg, 2020.*

8 *Municipality of the District of Lunenburg, 2013.*

9 *Ibid.*

responsible for asset management. As it defines roles and responsibilities for the team, a key next step could be to complete a staff competency review to identify required skillsets for natural asset management and to fill any essential gaps.

Staff has already identified potential areas of improvement for natural assets. MODL is looking into an approach to measure the condition of its natural assets and track condition over time, and is interested in doing a financial valuation of its natural assets through an ecosystems services valuation or replacement cost study. Both of these actions would support MODL in allocating appropriate budget to maintain or restore them.

MODL also identified developing a new a policy to acquire natural assets as a potential area of improvement.

Because asset management is a process of continuous improvement, MODL may benefit from identifying priority natural assets to begin its work to incorporate natural asset management into its overall asset management system and requirements.

6.2. Possible actions for the further development of the inventory

Based on the inventory, MODL could consider the following, regardless of whether or not it pursues a full natural asset management process. These are mostly incremental measures.

- Expand the risk identification to include field verification of results.
- Determine acceptable levels of risk to inform MODL's risk mitigation strategies (see Table 6).
- Develop adaptation measures to address flooding and amend the Hurricane Contingency Plan to include the role of utilities.
- Identify linkages between services and assets, and assess the condition of, and risks to, the assets from the perspective of their ability to deliver services.
- Share the inventory to stimulate collaboration with adjacent local governments.
- Add more condition ratings - for example, canopy cover - which also links to stormwater management services.
- Initiate or enhance monitoring - for example, using gauges, water level sensors, and loggers - to improve understanding of trends, feed into condition ratings of assets, and gather information for modelling.
- Maintain interest and momentum in natural asset management to move towards a full natural asset management project.

6.3. Steps to a full natural asset management project

If MODL wishes to proceed with a full natural asset management project, including implementation, it would need to consider the following:

1/ **Confirm scope, roles and responsibilities**. Undertake a meeting or workshop to confirm (a) assumptions [for example, that water management and development pressure are the primary services of concern] (b) roles, responsibilities and capacities (c) community capacity to undertake a larger project.

2/ **Fill essential knowledge gaps**. If discussions on scope and certainty and related data needs for modelling indicate the need for additional data, these could be filled.

3/ **Modelling**. Modelling the levels of service that natural assets currently provide, and the levels of service under different potential management, local climate change projections, and rehabilitation or restoration scenarios, is central to natural asset management as it gives communities the ability to explore how different actions will affect the health and corresponding performance of natural assets.

4/ **Economic assessment**. The economic assessment component provides a market-based indication of (a) the current value of the services from natural assets if they had to be provided by an engineered means, and (b) the costs and values of different interventions in terms of service delivery.

5/ **Planning**. This step allows local governments to explore different scenarios such as “what happens to the services provided by the wetland if there is significant building upstream?” or “what happens to the services if the forest is restored?” Using modelling, changes in service levels can be understood and quantified. Corresponding values can also be determined through continued economic assessment. Based on this foregoing, local governments can begin to consider and prioritize actions ranging from status quo to planning, regulatory, financial operations, maintenance, acquisition, and monitoring interventions.

6/ **Implementation**. The natural asset implementation phase is an adaptive management cycle, not a finite journey. It is during this time that actions identified based on the previous steps can begin to be implemented. MNAI can provide ongoing advice / guidance on policy pieces and integration of the above information for 12-18 months. After this point, the local government, together with local partners and service providers, would ideally have the capacity to continue these efforts on their own.

7/ **Ongoing monitoring**. Project monitoring is essential to learn whether interventions are working and to share lessons and learnings from other communities undertaking natural asset management. MNAI would typically stay involved with the community for three years through a monitoring arrangement to be established with the communities.

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Annex: Results of MODL risk identification

This Annex contains the results of the MODL's use of MNAI's risk identification tool, which they self-administered with guidance from MNAI. Annex Table 1 was the main product, developed by MODL personnel, that resulted from the exercise.

Step 1: Identification of risks

Common risks to natural assets:

- Overuse of trails/dumping
- Flooding (current and future)
- Forest fire
- Invasive species
- Development pressure
- Pollutant loading from urban, agricultural, or industrial sources (e.g., overuse of salt on roads)
- Drought (current and future)
- Erosion
- Ice jams
- Storm surge
- Lack of flood hazard mapping
- Lack of land management plans
- Lack of monitoring reports
- Construction activity
- Political policy change

Step 2: Complete survey

TABLE 1: SIMPLIFIED RISK IDENTIFICATION SURVEY

Risk	Ranking (L/M/H)	Assets Affected	Location	Notes
1/ Coastal flooding	H	Inland water Coastal wetlands Inland wetlands cliffs, dunes		Well inundations Wetlands contaminated with sea-water, drifted woods, and seaweed
2/ Forest fire	H	Forest, grassland and shrubland		Loss of habitats, ecosystem, soil stability, biodiversity. Expediated erosion
3/ Invasive species	H	All assets		Ticks, green crabs, Asian long-horned beetles, spruce bud worms, purple loosestrife, and hogweed
4/ Drought	H	All assets		More death of trees, loss of fish habitat, temporary loss of species and disease outbreak
5/ Erosion	M	All assets Coastal wetlands, cliffs, dunes, and beaches		Loss of habitats, wetlands contamination with seawater intrusion
6/ Ice jams	L	Inland water and forest		Temporary loss of use
7/ Storm surge	M	Coastal wetlands, cliffs, dunes, and beaches		Loss or relocation of assets
8/ Development pressure	H	Inland water, forest, wetlands		Surface water and nutrients runoff, eutrophication, algae bloom, sedimentation of waterway, increased chance of other risks, loss of habitat and water retention
9/ Hurricane (storm events)	H	All assets		Forest knockdown, other disasters (forest fire, erosion, flooding)

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