
photo credit: Laslovarga

Town of Lincoln


photo credit: Laslovarga


photo credit: Laslovarga


photo credit: Odyssey Virtual

Toward natural asset management in the

Town of Lincoln

Ontario

Summary of inventory results and recommendations
February 2022

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.

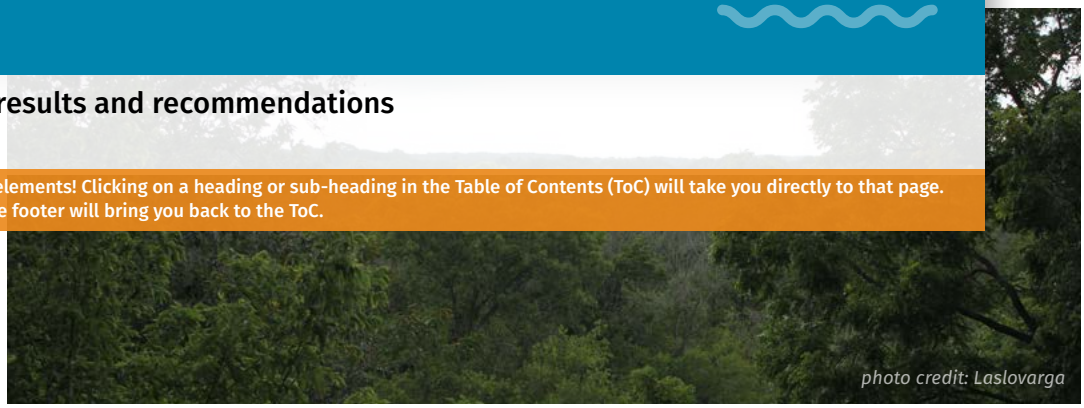
photo credit: Laslovarga

Municipal Natural Assets Initiative

MNAI.CA
Making Nature Count

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.

Please cite as:
Municipal Natural Assets Initiative (MNAI). (2021). Toward natural asset management in the Town of Lincoln, Ontario. Summary of inventory results and recommendations. MNAI.ca

Table of Contents

1 Purpose

This document summarizes the results of a project to develop a natural asset inventory for the Town of Lincoln 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 assets. Doing so can enable local governments to better 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?

Natural asset inventories provide details on the types 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.

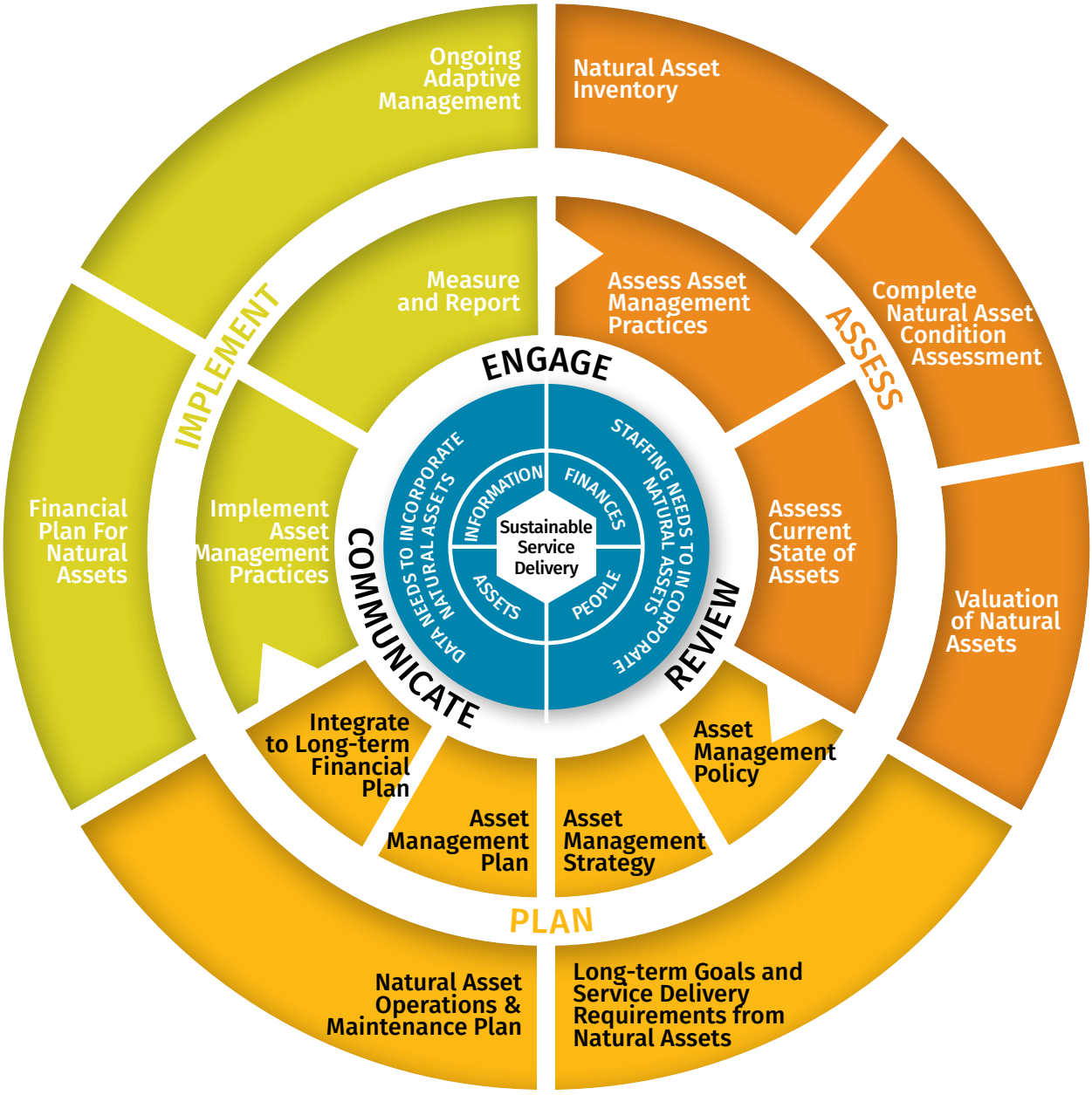

***Figure 1**: The Asset Management Process. MNAI has adapted this for use with natural assets.*

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

3 Local government context

3.1. General

Figure 2:
Town of Lincoln[3].

The Town of Lincoln (population ~23,800) is located between the southern shore of Lake Ontario and the Niagara Escarpment Region[4].

The Town of Lincoln's interest in natural asset management is two-fold. First, it wants to increase its ability to adapt to the impacts of climate change by developing a Climate Adaptation Plan and Asset Management Plan that include consideration of natural assets. Second, a natural asset inventory will support the Town of Lincoln's Tree Manual, which promotes urban tree canopy, and its fill bylaw, which regulates grading and deposition of fill as well as tree removals.

The Town of Lincoln identifies urban tree canopy and the natural asset components of low-impact developments as priority natural assets. It identifies development pressure as a key risk. In this context, the Town of Lincoln recognizes the challenges of designing stormwater management systems that properly convey flow from upstream sources. Thus, stormwater management and flood management are high priority services.

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 has adapted the Federation of Canadian Municipalities (FCM)'s asset management readiness assessment tool[5] to help local governments measure their progress on both asset management and natural asset management in four competency areas, with each area describing outcomes based on five levels of progress or maturity.

3 *Wikipedia. Retrieved August 2021 from Wikipedia. Retrieved August 2021 from en.wikipedia.org/wiki/Lincoln,_Ontario.*

4 *Lincoln Official Plan. (2018, December). Retrieved August 2021, from lincoln.ca/official-plan*

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

The completed readiness assessment helps local governments prioritize actions that increase their effectiveness in managing all assets, including natural ones.

Competency 1: Policy & Governance

The Town of Lincoln is at a relatively early stage of adoption of policy- and governance-related aspects of asset management. While it does have an asset management roadmap, it does not yet have an asset management policy. It has a green infrastructure guide that provides some direction on how natural assets will be protected and managed, but that guide had not yet gone to Council for approval as of September 2021. To-date, there are no other ways in which natural assets have been formally integrated into asset management planning. The Town of Lincoln is starting to collect baseline information on asset management practices to measure progress.

Competency 2: People & Leadership

The Town of Lincoln has a cross-functional asset management team that works within the organization to lead, communicate, and support asset management improvement and organizational changes, and there is a dedicated staff person responsible for integrating natural asset management considerations. There are formal terms of reference for this work, although they do not yet include details for incorporating natural asset management. Work is ongoing to articulate asset management system roles and responsibilities into job descriptions.

Council has demonstrated buy-in and support for asset management and has approved funding for priority improvements. It has also demonstrated buy-in for priority initiatives that will improve natural asset management and incorporate it into core asset management business practices.

Competency 3: Data & Information

The Town of Lincoln has basic inventory data for all engineered assets across the organization, with some level of service information and standardized condition ratings. It has defined life-cycle investment requirements and levels of service for critical assets and has linked asset management and financial information for them. Asset management plans for different service areas are at different stages and levels of detail. This natural asset inventory project is the Town of Lincoln's first effort to capture data on natural assets; thus, considerations around natural assets have not yet been integrated into asset management plans.

With respect to financial information, the Town of Lincoln has captured capital and operating expenditure data for most engineered assets and can demonstrate the gaps between forecasted infrastructure needs and current spending levels. It has not yet captured financial information for natural assets other than for the cost of street tree replacements.

Competency 4: Planning & Decision-making

The Town of Lincoln has a structured asset investment planning approach, but application is inconsistent. It sets priorities using similar criteria based on organizational goals and objectives. The approach does not yet include considerations for how investments in natural assets will be determined or prioritized.

For engineered assets, the Town of Lincoln's asset management plans are based on short- and long-term issues and priorities. The Town of Lincoln has developed detailed asset management plans for most services that include basic needs forecasting and risk management strategies for critical assets, but there is still a need to finalize plans based on projected lifecycle costs. The current plans do not yet bring in considerations around natural asset management, although the Town of Lincoln is addressing protection of its shoreline and beaches through environmental assessments of shoreline roads.

The Town of Lincoln is currently working on a "level four" for budgets and financial planning; this means that it prepares annual, needs-based capital and operating budgets based on annual reassessments of risks and current needs. It has a 10-year capital plan and updates it annually and is working on a long-term financial plan that would be updated annually to help understand risks associated with its investment gap. Finally, it is beginning to build in capital, operating and maintenance costs for at least one natural asset.

4 Natural asset inventory

4.1. Inventory overview

MNAI's natural asset inventories have two main components to express natural asset information: an asset registry (which is a tabular representation of the data) and an online dashboard. MNAI provided the registry to the Town of Lincoln in an Excel file and the dashboard as a website address. 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

To establish the inventory, MNAI obtained data from the Town of Lincoln, Ontario GeoHub, the Niagara Peninsula Conservation Authority, and Niagara Open Data. MNAI combined the spatial data layers to establish a comprehensive depiction of natural assets. Table 1 describes the data sources used to develop the inventory and complete the condition assessment.

TABLE 1: SUMMARY OF DATA SOURCES

DATASET NAME	DESCRIPTIVE NAME	SOURCE	PURPOSE
Aims_Lincoln_Boundary	Aim Lincoln Boundary	Lincoln	Used to delineate study area
ELC_Final_2020	Updated ELC	Niagara Region	Used as main landcover source for location of natural assets
OLCC_V2	Ontario Landcover Compilation	Ontario GeoHub	Used to fill in landcover where ELC not present (agricultural land, community infrastructure, extraction sites, etc.)
Built_up_Area	Built-up Area	Ontario GeoHub	Used to fill in landcover where ELC not present (impervious and pervious areas)
_10K_ Waterbodies__30K_300K_	10K Waterbodies 30K 300K	Niagara Peninsula Conservation Authority (NPCA)	Used to capture open water not represented in the ELC or the Ontario Landcover Compilation
Subwatersheds_2k		Niagara Peninsula Conservation Authority (NPCA)	Used to split natural assets by subwatershed to be able to filter by relevant subwatershed in the inventory dashboard
Lims_Lincoln_Parcels	Lincoln Ownership Parcels	Lincoln	For privacy reasons, parcels were filtered for relevant publicly owned property such as Lincoln Town and Niagara Peninsula Conservation Authority. Data needed cleaning due to different spelling of the same entities
Lims_Lincoln_OPA_ CentralBusinessDistrict	Lincoln OPA Central Business District	Lincoln	Used to summarize natural asset area of overlap with the central business district
Lims_Lincoln_OPA_ GeneralCommercial	Lincoln OPA General Commercial Land Use	Lincoln	Used to summarize natural asset area of overlap with general commercial land use
Lims_Lincoln_OPA_ HighDensityResidential	Lincoln OPA High Density Residential Land Use	Lincoln	Used to summarize natural asset area of overlap with high density residential areas
Lims_Lincoln_OPA_ Industrial	Lincoln OPA Industrial Land Use	Lincoln	Used to summarize natural asset area of overlap with industrial areas

TABLE 1: SUMMARY OF DATA SOURCES

DATASET NAME	DESCRIPTIVE NAME	SOURCE	PURPOSE
Lims_Lincoln_OPA_ LowDensityResidential	Lincoln OPA Low Density Residential Land Use	Lincoln	Used to summarize natural asset area of overlap with low density residential areas
Lims_Lincoln_OPA_ MediumDensity Residential	Lincoln OPA Medium Density Residential Land Use	Lincoln	Used to summarize natural asset area of overlap with medium density residential areas
Lims_Lincoln_OPA_ MixedUse	Lincoln OPA Mixed Use Land Use	Lincoln	Used to summarize natural asset area of overlap with mixed land use
Lims_Lincoln_OPA_ NaturalEnvironment	Lincoln OPA Natural Environment	Lincoln	Used to summarize natural asset area of overlap with natural environmental land use
Lims_Lincoln_OPA_ Neighbourhood Commercial	Lincoln OPA Neighbourhood Commercial Land Use	Lincoln	Used to summarize natural asset area of overlap with neighbourhood commercial land use
Lims_Lincoln_OPA_ NPCARegulated Shoreline	Lincoln NPCA Regulated Shoreline	Lincoln	Used to perform data quality along the shoreline area
Lims_Lincoln_OPA_ OnStKingStIntensification Corridor	Lincoln Ontario St King St Intensification Corridor	Lincoln	Used to summarize natural asset area of overlap with these land use designations
Lims_Lincoln_OPA_ Residential	Lincoln OPA Residential Land Use	Lincoln	Used to summarize natural asset area of overlap with residential land use designations
Lims_Lincoln_OPA_ ParksandOpenSpace	Lincoln OPA Parks and Open Space Land Use	Lincoln	Used to insert missing built-up pervious polygons into base landcover dataset and then to summarize natural asset area of overlap with the parks and open space land use designation
Lims_Lincoln_OPB_ ParksandOpenSpace	Lincoln OPB Parks and Open Space Land Use	Lincoln	Used to insert missing built-up pervious polygons into base landcover dataset and then to summarize natural asset area of overlap with the parks and open space land use designation

TABLE 1: SUMMARY OF DATA SOURCES

DATASET NAME	DESCRIPTIVE NAME	SOURCE	PURPOSE
Lims_Lincoln_OPB_ GeneralCommercial	Lincoln OPB General Commercial Land Use	Lincoln	Used to summarize natural asset area of overlap with general commercial land use
Lims_Lincoln_OPB_ HighDensityResidential	Lincoln OPB High Density Residential Land Use	Lincoln	Used to summarize natural asset area of overlap with high density residential areas
Lims_Lincoln_OPB_ LowDensityResidential	Lincoln OPB Low Density Residential Land Use	Lincoln	Used to summarize natural asset area of overlap with low density residential areas
Lims_Lincoln_OPB_ MediumDensity Residential	Lincoln OPB Medium Density Residential Land Use	Lincoln	Used to summarize natural asset area of overlap with medium density residential areas
Lims_Lincoln_OPB_ NaturalEnvironment	Lincoln OPB Central Business District	Lincoln	Used to summarize natural asset area of overlap with natural environmental land use
Lims_Lincoln_OPB_ Residential	Lincoln OPB Residential Land Use	Lincoln	Used to summarize natural asset area of overlap with residential areas
Lims_Lincoln_Zoning_ Boundaries	Lincoln Zoning Parcel Boundaries	Lincoln	Used to assign zoning codes to natural assets by assigning the code from the zoning polygon with the greatest area of overlap to the natural asset
Trims_Lincoln_Roads_ Regional	Lincoln Regional Roads	Lincoln	Roads datasets were combined to summarize the length (km) of roads within a 100m buffer surrounding assets for the road density condition assessment
Trims_Lincoln_Roads_ Unassumed	Lincoln Unassumed Roads	Lincoln	Roads datasets were combined to summarize the length (km) of roads within a 100m buffer surrounding assets for the road density condition assessment
NiagaraTrails	Niagara Bike Trails	Niagara Open Data	Used to indicate assets with trails running through them and the length (km) of trails

TABLE 1: SUMMARY OF DATA SOURCES

DATASET NAME	DESCRIPTIVE NAME	SOURCE	PURPOSE
ConservationTrails	Conservation Authority Trails	Niagara Peninsula Conservation Authority (NPCA)	Used to indicate assets with trails running through them and the length (km) of trails
Lims_Lincoln_ GreenbeltBoundary	Greenbelt Boundary Lincoln	Niagara Open Data	Used to indicate assets overlapping with the Greenbelt boundary and summarize the area of overlap
Conservation_Areas	Conservation Areas	Niagara Peninsula Conservation Authority (NPCA)	Used to indicate assets overlapping with Niagara Peninsula Conservation areas and area of overlap
NPCA_Approximate_ Regulation_Lands	NPCA Regulated Lands	Niagara Peninsula Conservation Authority (NPCA)	Used to indicate assets under NPCA regulation and natural asset area overlap with NPCA regulated areas
Contemporary_Mapping_ of_Watercourses	Watercourses	Niagara Open Data	Used to summarized length of streams/ creeks within natural assets
AgriculturalLandBase	Agricultural Land Base	Niagara Open Data	Used to assign agricultural land policy designations to natural assets by assigning the code from the agricultural land base polygon with the greatest area of overlap to the natural asset
OTN_Segment_Derived	Ontario Trail Network	Ontario GeoHub	Used to indicate assets with trails running through them and the length (km) of trails
Regulated_Floodplain_ Extent	Regulated Floodplain Extent	Niagara Peninsula Conservation Authority (NPCA)	Used to indicate natural assets falling within the floodplain and summarize natural asset area within the floodplain

The inventory project defined a total of 5,588 individual assets, covering 14,312 hectares (ha), as noted in Table 2. An asset is defined as a continuous area of the same land cover type. For example, an intact forested area would be defined as one asset, but a forested area that is bisected by a road would constitute two assets. The majority of the asset area in the Town of Lincoln was agriculture and undifferentiated rural land use.

TABLE 2: SUMMARY OF NATURAL ASSETS BY TYPE

NATURAL ASSET TYPE	NUMBER OF ASSETS	TOTAL AREA (HA)
Agriculture and Undifferentiated Rural Land Use	3,593	10,631
Built-up Pervious*	97	184
Cliff/Bluff/Talus	38	12
Coniferous Forest	37	46
Deciduous Forest	634	1,527
Forest (Other)	71	64
Meadow/ Successional	424	449
Mixed Forest	65	98
Open Aquatic	120	226
Open Shoreline	19	4
Rock Barren	2	1
Swamp	305	809
Wetland	183	262
Total	5,588	14,312

** Built-up pervious includes manicured lawns and greenspaces (e.g., sports fields)*

Figure 3 shows the spatial distribution of the natural assets.

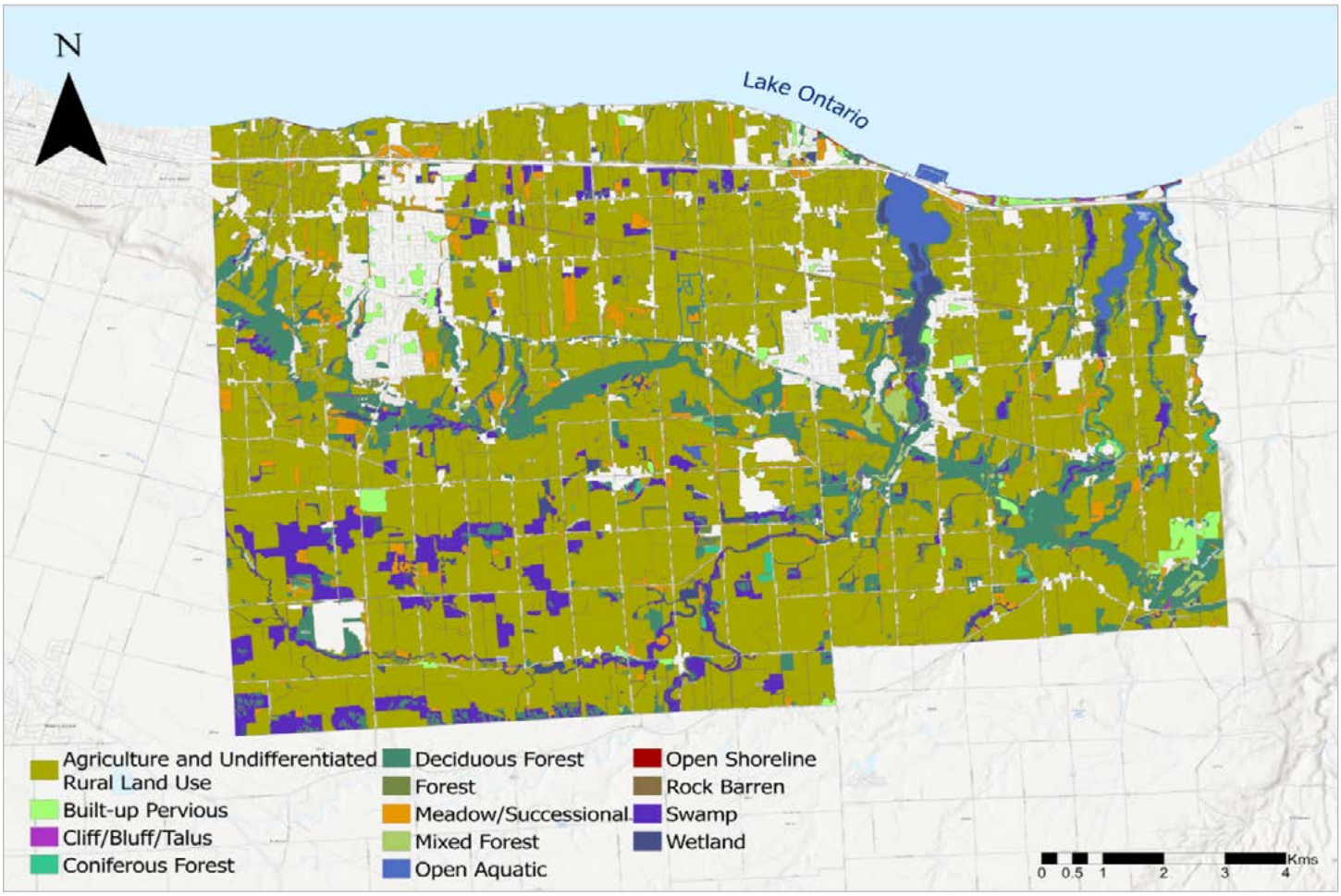

***Figure 3**: Spatial distribution of natural assets.*

4.3. Asset registry

Each asset within the inventory has a unique identification number that allows users to select and analyze individual assets and to manipulate the corresponding data as required. For example, changes in condition can be noted for individual assets. Information on each asset is housed in an asset registry. Table 3 is an excerpt from the Town of Lincoln's online registry showing natural asset characteristics and details. Additional detail is provided in the online dashboard.

TABLE 3: EXCERPT FROM THE REGISTRY

Natural Asset Registry

Asset ID	Asset Type	ELC/Landcover	Sub-Asset ID	Asset Area (ha)	Asset Area (ha) in Subwatershed	Subwatershed	Stream/ Creek Length (km)	Conservation Area (ha)	Conservation Authority Name	ON Trail Network Length (km)	ON Trail Network Name(s)	NPCA Regulation Area (ha)	Interior Forest (ha)	Adjacent Land Use Score	Permeability Score	Relative Size Score	Road Density Score	Total Score
AGR1000	Agriculture and Undifferentiated Rural Land Use	Agriculture and Undifferentiated Rural Land Use	AGR1000-1	0.01	0.01	Fsem Eighteen Mile Creek	0	0		0.00		0.00	0	4	5	1	1	11
AGR1001	Agriculture and Undifferentiated Rural Land Use	Agriculture and Undifferentiated Rural Land Use	AGR1001-1	0.01	0.01	Fsem Fifteen Mile Creek	0	0		0.00		0.01	0	9	5	1	10	25
AGR1002	Agriculture and Undifferentiated Rural Land Use	Agriculture and Undifferentiated Rural Land Use	AGR1002-1	0.00	0.00	Fsem Eighteen Mile Creek	0	0		0.00		0.00	0	6	5	1	1	13
AGR1003	Agriculture and Undifferentiated Rural Land Use	Agriculture and Undifferentiated Rural Land Use	AGR1003-1	0.02	0.02	Fsem Lake Ontario 15	0	0		0.00		0.00	0	5	5	1	1	12
AGR1004	Agriculture and Undifferentiated Rural Land Use	Agriculture and Undifferentiated Rural Land Use	AGR1004-1	0.01	0.01	Twen Twenty Mile Creek	0	0		0.00		0.01	0	6	5	1	1	13
AGR1006	Agriculture and Undifferentiated Rural Land Use	Agriculture and Undifferentiated Rural Land Use	AGR1006-1	5.16	0.79	Lin Prudhomme Creek	0	0		0.00		0.25	0	7	5	1	1	14
AGR1006	Agriculture and Undifferentiated Rural Land Use	Agriculture and Undifferentiat	AGR1006-2	5.16	4.37	Lin Vineland Drain	0	0		0.00		1.34	0	8	5	1	10	24
Total					**14311.78**		**46**	**308**		**71.43**		**4,710.71**	**118**					

4.4. Online dashboard

Inventories may provide more insights when characterized 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 4 is a screenshot from the dashboard that MNAI provided to the Town of Lincoln. The full version can be accessed at *go.greenanalytics.ca/Lincoln*.

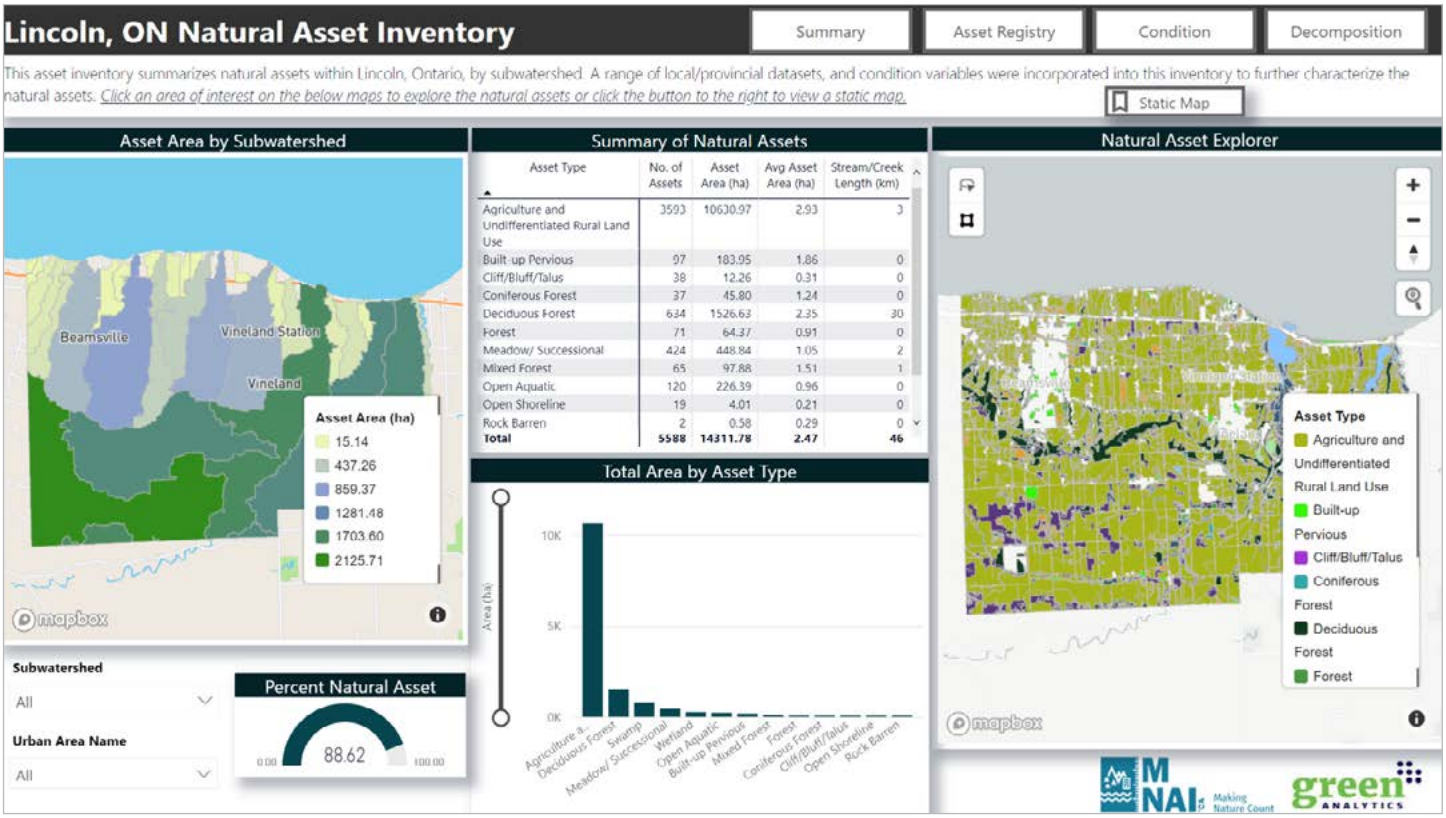

Figure 4: Screenshot of main inventory summary.

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-based condition assessment and built it into the inventory to provide an initial understanding of the status of the natural assets for the Town of Lincoln. As part of a full natural asset management project, MNAI would expand this assessment to include additional metrics related to condition (e.g., relative biodiversity, riparian and wetland health, soil condition, connectivity, and others). The expanded assessment could also employ site visits to confirm and verify the condition ratings. The desktop exercise completed as part of this inventory is a reasonable first step in assessing condition and can be used as a foundation for future work in this area.

Table 5 summarizes the condition assessment steps and indicators. These indicators were chosen for their relative ease of measurement (given time and budget constraints) and for their relevance to measuring the ecological health and service delivery capabilities of natural assets. They are proxy metrics for these broader condition considerations. For example, larger asset size implies more connectivity of natural areas, higher road density implies

more fragmentation and higher hydrologic impairment of water flows, and more permeability implies greater ability to store water which means more effective stormwater management. The adjacent land use metric measures and distinguishes natural assets that are next to other natural assets from natural assets that are next to built infrastructure. How and the extent to which a given natural asset is influenced by the drainage in the adjacent landscape varies depending on factors such as the local topography and soils, orientation (e.g., upland versus lowland, position in the watershed) and the size and nature of the feature itself. However, it is well-established that the condition of a natural asset in an urban context tends to be negatively impacted when more of the surrounding land uses are impervious (i.e., paved, concrete or buildings) because this tends to alter pre-existing drainage and infiltration pathways, which can cause a natural area to receive much more or much less drainage than prior to being in an urban context. Urban runoff also typically carries a host of sediments and contaminants, and when such runoff is directed to natural areas and not properly treated, it can negatively impact the feature and its functions for plants and wildlife.

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 km squared), medium density (assets with between 1km and 2km of roads per km squared) and low density (assets with less than 1km of road per km squared).	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*

TABLE 4: CONDITION ASSESSMENT APPROACH AND INDICATORS		
Indicator	**Description & Methods for Quantification**	**Data used to Quantify Indicator***
Adjacent land use	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. If there are no human land uses within 100 m of the assets, the assets are scored 10. If there are intensive land uses within 100 m of the assets, the score is 0.	Natural asset inventory plus spatial representation of land use as well as intensity rankings of land uses

** Data sources provided in Table 1 unless noted here.*

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 as 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 5 summarizes the natural asset condition assessment results per the online dashboard.

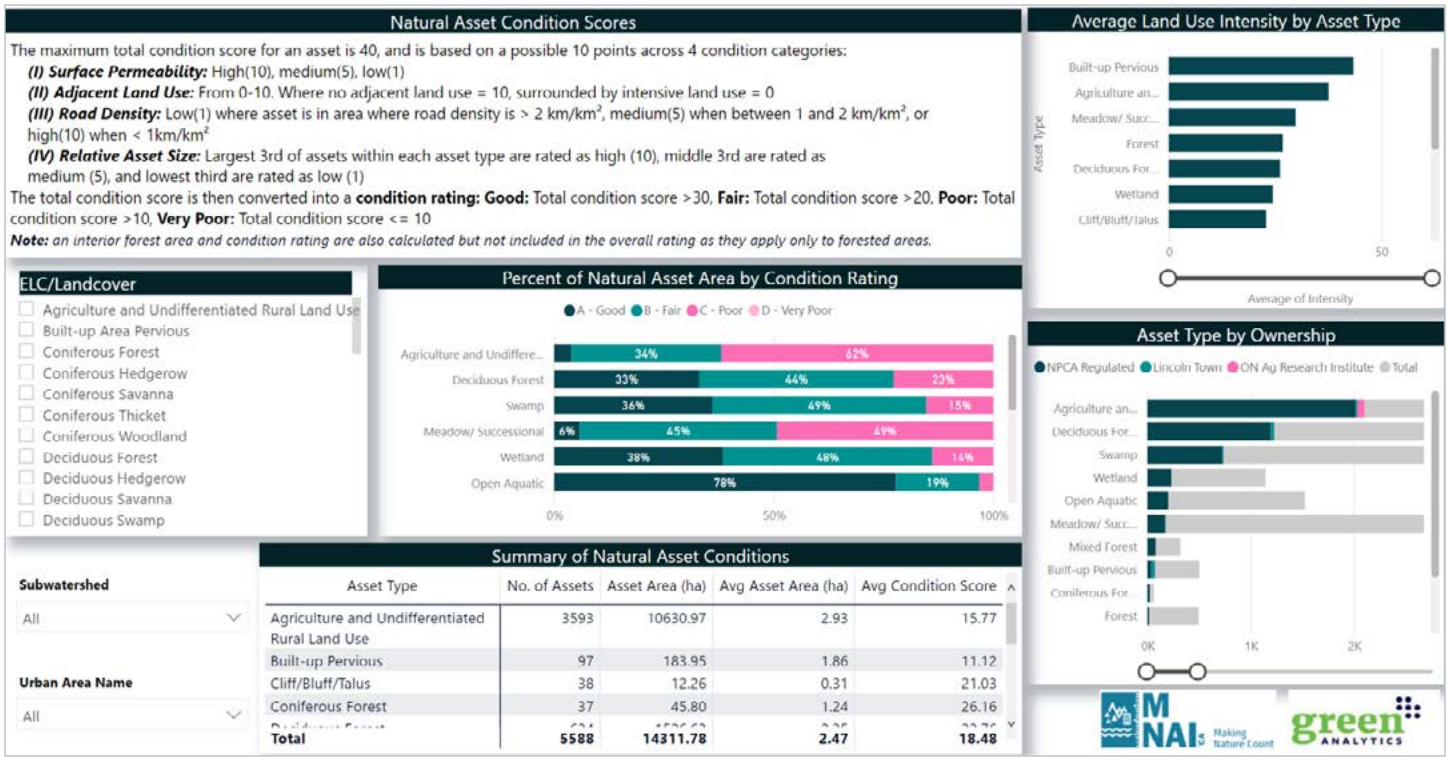

Figure 5: Screenshot of condition assessment details.

Overall, about 1,602 ha (or 11 per cent) of natural assets were assessed in good condition and 5,232 ha (or 37 per cent) were assessed in fair condition.

Table 5 summarizes condition ratings by rating result.

TABLE 5: SUMMARY OF NATURAL ASSET CONDITION RATINGS

Condition Rating	Number of Assets	Total Area (ha)	Average Condition Score
Good	145	1,602	32.83
Fair	1,797	5,232	25.18
Poor	3,592	7,426	14.43
Very poor	66	51	8.08
Total	**5,588**	**14,312**	**18.48**

Figure 6 summarizes condition by natural asset type. The forest assets largely ranked good and fair, while agriculture and built-up pervious (i.e., manicured lawn space) had some areas rated as poor. Additional insights on the condition results can be obtained through the "Decomposition" tab of the online dashboard.

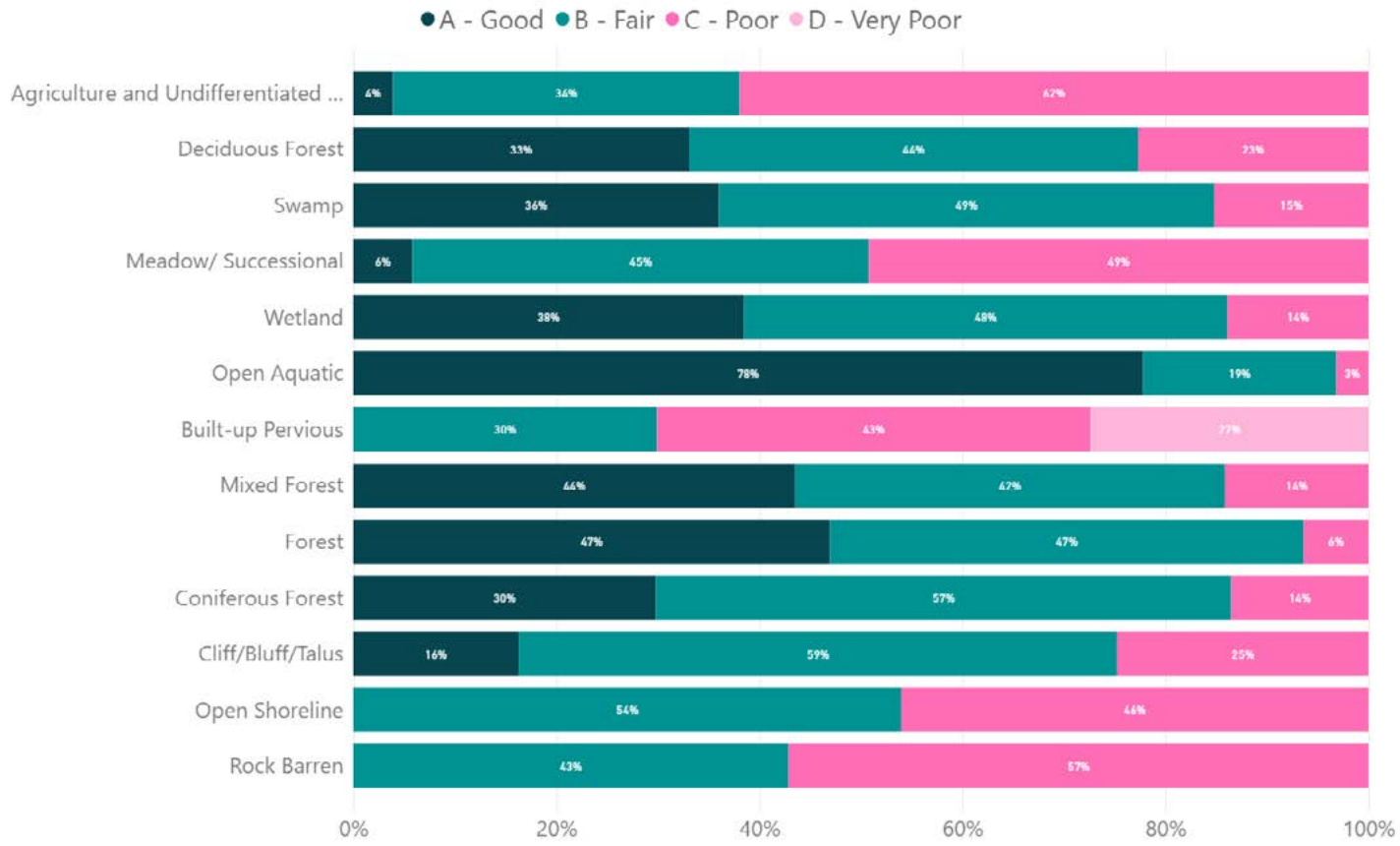

***Figure 6**: Summary of condition rating by natural asset type.*

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 asset management focus emerge. That said, 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 by identifying the top risks to natural assets and their associated services, plus 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 the Town of Lincoln 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, the Town of Lincoln considered possible risks that the loss of natural asset functions could pose to environmental sustainability, public health and safety, public administration, the local economy, and community lifestyle, including:

- Forest fire
- Construction activity
- Overuse of trails and dumping
- Ice jams
- Lack of land management plans
- Development pressure
- Political policy change
- Erosion
- Increased variability in temperatures and precipitation[6]

6 *Note: The risk 'Increased variability in temperatures and precipitation' was explored in detail and included 12 related risks (e.g., more frequent/severe droughts, more cooling degree days). These are addressed further below.*

Each risk was then ranked on a scale of 5 – 125 with a focus on climate impacts. This ensured that existing work on risk to engineered assets aligns with natural asset risk considerations. To assess impact and consequence, the Town of Lincoln considered five questions:

i/ What is the impact associated with the risk?

ii/ How vulnerable is the Town of Lincoln to the impact (determined through sensitivity and adaptive capacity)?

iii/ What is the likelihood of the impact?

iv/ What is the consequence of the impact (assessed across a range of departments)?

v/ What can be done to mitigate the probability of impact and/or consequence?

5.3. Results of the risk identification process

The risk identification process revealed:

- 0 high-level risks
- 3 medium-level risks (forest fire, construction activity, and increased variability in temperature and precipitation)
- 6 low-level risks (overuse of trails & dumping, ice jams, lack of land management plans, development pressure, political policy change, and erosion)

In terms of scope, the identified risks affect natural assets across the Town of Lincoln with many also having economic, personal health and safety, and community and lifestyle impacts. The locations and ecosystem types associated with the different risk categories were not explored.

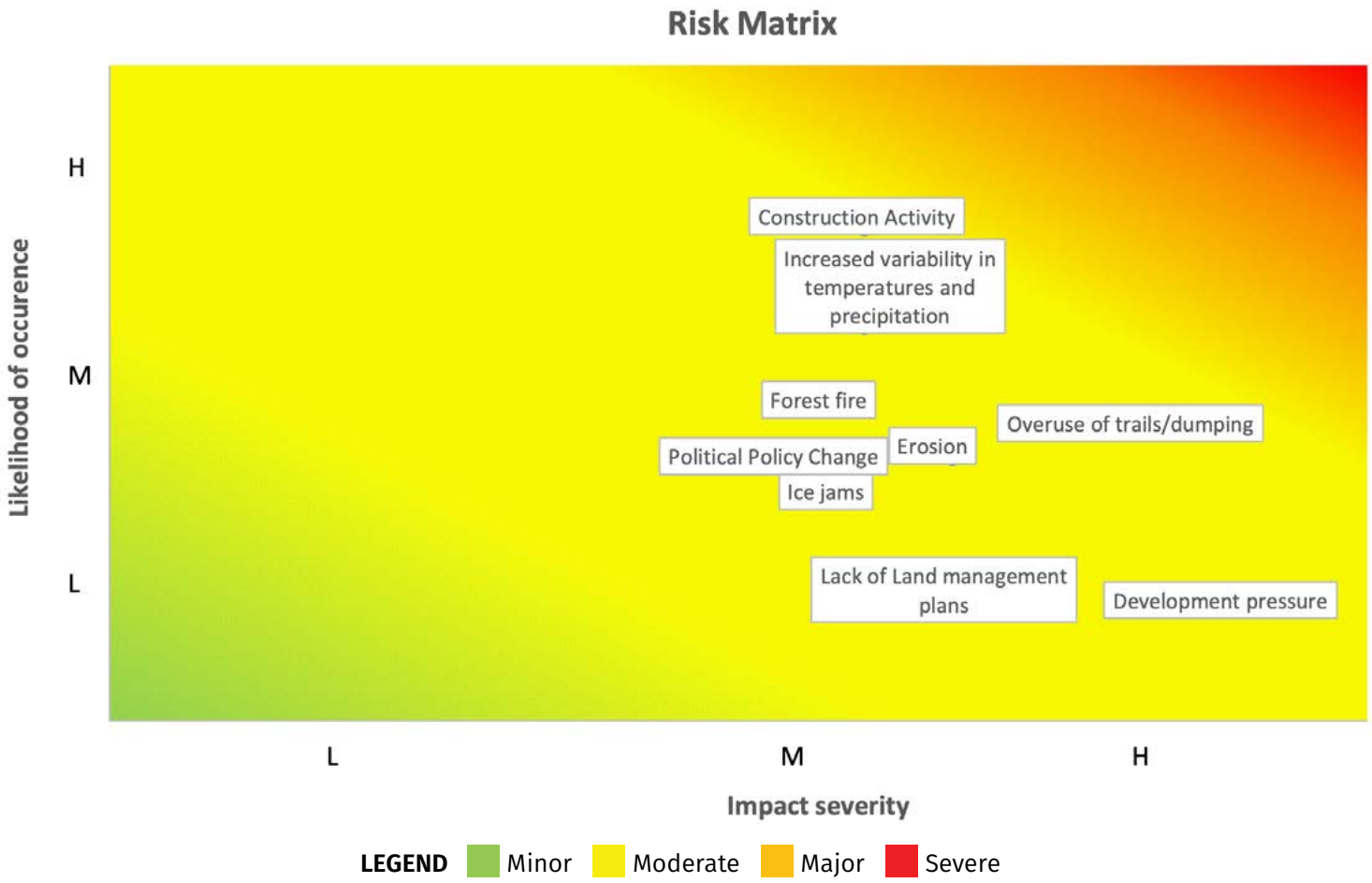

Figure 7: Results of risk identification process.

5.4. Potential priorities for the local government

The outcomes of the risk identification process highlight potential priorities on which the Town of Lincoln could focus their natural asset management efforts. Where possible, these are also informed by the condition assessment. These are:

- **Forest fire:** The Town of Lincoln identified forest fire as a medium-level risk and noted the potential impacts of grass fires leading to increased public health and fire emergency costs or the implementation of fire bans. The likelihood of this risk is considered moderate, with possible fires anticipated once in a 10-year period. Consequences are also moderate and include a small number of injuries, reduction in economic performance, a decline in services, increased pressure on public administration, and isolated but significant environmental damage that can be reversed with intensive effort. Although fire is a natural process and often operates as an integral part of the ecosystem in which it occurs, human impacts (and particularly climate change) can result in severe fires that affects not just vegetation, but the soil and water resources of an ecosystem, which are critical to overall ecosystem functions, processes, and services. As an example, the province has a Wild Fire Management Strategy, and the Town of Lincoln has enacted bans and signage on trails to restrict the use of open fires.

- **Construction activity:** Construction activity was identified as a medium-level risk with potential impacts including lower water tables, minor instances of environmental damage, and increased infrastructure maintenance, repairs, and labour costs. The most significant impacts identified relate to extreme heat, cold, and variability, which in addition the range of impacts on engineered infrastructure (e.g., watermain breaks, culvert freezing) can have long-term impacts resulting from groundwater depletion. These include deterioration of water quality, reduction of water in streams and lakes, and/or land subsidence. The Town of Lincoln should consider use of materials that can withstand extreme temperatures and weather, as well as implement ground and surface water monitoring to better understand environmental impacts.

- **Increased variability in temperatures and precipitation:** A number of medium-level risks related to increased variability in temperatures and precipitation were identified, including: more cooling degree days, milder winter temperatures, increased temperature variability in shoulder seasons, increased extreme weather and temperatures, increased annual temperatures, more frequent and severe extreme weather events, more frequent and severe freezing rain events, more growing degree days, more heavy rainfall events, more hot days above 30 degrees Celsius, and winter precipitation changes. Of these, increased extreme weather and temperatures, and increased annual temperatures were ranked highest. Increased extreme weather and temperatures can result in increased health and safety risks particularly amongst vulnerable populations, decreased worker productivity, impacts to tourism and the local economy, and stress to natural assets (e.g., increased lake levels leading to erosion, increased rainfall during winter months leading to overland flooding). The Town of Lincoln has indicated it has established health and safety measures, the use of social media notices, and tourism ads to warn its community of hazards. In addition, planning and budgeting for increased maintenance of natural assets (e.g., tree watering, bank maintenance) should begin. Increasing annual temperatures can increase water quality impacts, green algae blooms, vector-borne illness, and thawing permafrost. Alternatives to chlorine treatment, collaboration with the Region, and working with public health were identified as adaptation and mitigation measures. Wherever possible, using natural processes for water purification (e.g., riparian restoration) can be a cost-effective strategy.

Table 6 lists and provides brief descriptions of risk mitigation strategies. Future stages of the MNAI process can address these.

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

6 Recommendations

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 (6.1) opportunities to strengthen natural asset management at an organization-wide level (6.2) possible actions for the further development of the inventory, and (6.3) steps the Town of Lincoln can consider to advance to a full natural asset management initiative.

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

This natural asset management inventory project will support the Town of Lincoln in integrating natural asset management considerations into asset management practices. The data this project provides is a foundation for understanding the scope of natural assets the Town of Lincoln needs to consider along with the risks, which will help them prioritize efforts.

If the Town of Lincoln moves forward with the adoption of an asset management policy, then that policy should explicitly refer to the services that natural assets provide. Similarly, any future asset management roadmap or strategy should include objectives for integrating natural asset management considerations across service areas. To strengthen support for natural asset management among Council, staff could share this natural asset inventory and potential next steps required to strengthen natural asset management with them.

While there is a designated staff person on the asset management committee responsible for incorporating natural asset considerations, roles and responsibilities related to natural asset management could be defined in appropriate job descriptions.

It will take time to build in natural asset considerations into all asset management plans in the organization. Thus, it is recommended to begin with priority service areas where risks to natural assets have been identified through this project. It is also suggested to consider how analysis around natural asset management could be brought into broader policy, plans or master plans the Town of Lincoln may develop.

6.2. Possible actions for the further development of the inventory

Based on the inventory, the Town of Lincoln 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 process to include locations where each risk is being occurring and what asset classes are being impacted.
- Determine acceptable levels of risk to the Town of Lincoln's risk mitigation strategies (see Table 6).
- Further develop the condition assessment and risk assessment for the urban tree canopy (the identified priority asset) using local climate projections, land use modelling, and other data already at their disposal.
- 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. From a stormwater management and flood mitigation perspective, watercourses, wetlands and forested areas in the watersheds will be key.
- Share the inventory with adjacent local governments to stimulate collaboration within the watershed.
- Initiate or enhance groundwater and surface water monitoring - for example, using gauges, water level sensors, piezometers, and loggers to improve understanding of trends, feed into condition ratings of assets, and gather information for modelling.
- Schedule regular updates (e.g., every 3-5 years) of the inventory, condition assessment and risk identification to understand trends.
- 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 the Town of Lincoln wishes to proceed with a full natural asset management project, including implementation, it will need to consider the following steps:

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 the 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**. MNAI can provide ongoing advice / guidance on policy pieces and integration of the above information for 12-18 months. After that, the local government, together with local partners and service providers, would ideally have the capacity to continue efforts on their own.

7/ **Ongoing monitoring**. It is essential to continue monitoring the project 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.

Sources

Federation of Canadian Municipalities. October 2018. Asset Management Readiness Scale: Municipal Asset Management Program. *fcm.ca/sites/default/files/documents/resources/tool/asset-management-readiness-scale-mamp.pdf*

MNAI. Defining and Scoping Municipal Natural Assets. June 2017. *mnai.ca/media/2019/07/SP_MNAI_Report-1-_June2019-2.pdf*

MNAI. Results from the First National Cohort. Decision-maker summary. 2018. *mnai.ca/media/2019/08/spmnaijuly31-summaryweb.pdf*

MNAI. Cohort 2 National Project Overview. February 2020. *mnai.ca/media/2020/02/MNAI-CohortSummary.pdf*

Annex: Results of the Town of Lincoln's risk identification process

This Annex contains the results of the Town of Lincoln's use of MNAI's risk identification tool, which they self-administered with guidance from MNAI. Table 7 is a summary of the main product that personnel developed 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 7: SIMPLIFIED RISK IDENTIFICATION SURVEY

Major Risks	Vulnerability	Likelihood	Consequence	Score & Risk Ranking	Impact notes
Forest fire	3		3	**45 Medium**	Increased risks of grass fires leading to increased public health and fire emergency costs, or implementation of fire bans.
Construction activity	2.5	4.5	2	**49 Medium**	Lowered water table resulting in increased watermain breaks leading to increased maintenance & labour costs; Extreme heat, cold, and variability (freeze-thaw cycles) resulting in increased damage (frost heaving, culvert freezing, watermain breaks, storm sewer freezing, bridge damage, reduced asphalt lifecycle) to infrastructure (roads, culverts, sidewalks, trails, parking lots, and outdoor recreation facilities) leading to increased preventative maintenance, repair, and labour costs.
Overuse of trails/ dumping	3	5	1.5	**35 Low**	Overuse could lead to damage or litter to vegetation along trails.
Ice jams	3	4	1.5	**28 Low**	Work with the NPCA to eliminate ice jams.
Lack of land management plans	5	4	1.5	**32 Low**	Review incentives from the Feds and the Province. Look to municipalities that have management plans in place.
Development pressure	5	4	1.5	**28 Low**	The impacts of the future development of Prudhommes are being addressed by the Town, Region, NPCA, MTO and regulatory bodies.

TABLE 7: SIMPLIFIED RISK IDENTIFICATION SURVEY

Major Risks	Vulnerability	Likelihood	Consequence	Score & Risk Ranking	Impact notes
Political policy change	4	4	1.5	**32 Low**	With the change of those in all levels of government there may be additional pressure on the impact to the environment.
Erosion	4	4	1.5	**28 Low**	Erosion to be addressed at the development stage. Existing features prone to erosion to be addressed with assistance of the NPCA and the Region.
Increased variability in temperatures and precipitation	3	4	3	**53 Medium**	Increased lake level variability and extreme weather leading to shoreline damage /erosion/ wave uprush hazards resulting in public health/emergency response/evacuation costs. Increased rainfall events during winter while ground is frozen, resulting in overland flooding.

Municipal Natural Assets Initiative