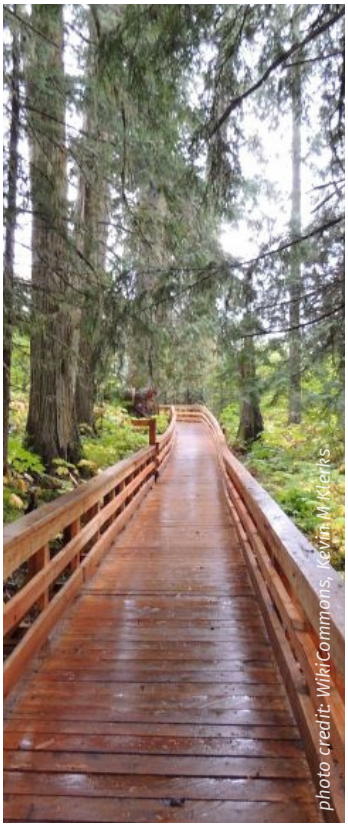
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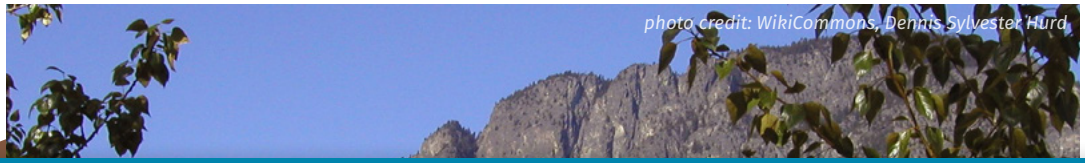
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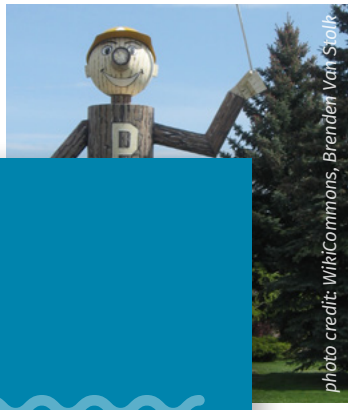
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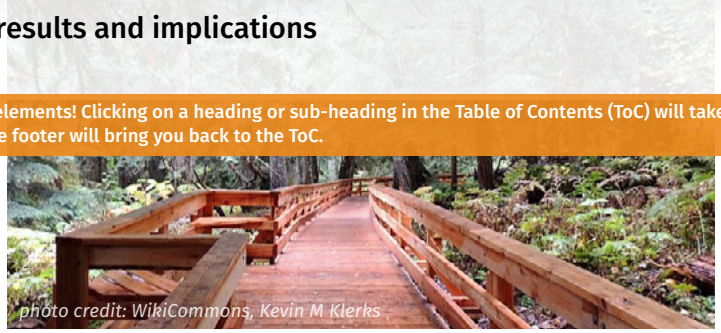
Toward natural asset management in the

City of Prince George

British Columbia

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

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.

Disclaimer

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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 City of Prince George, 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.

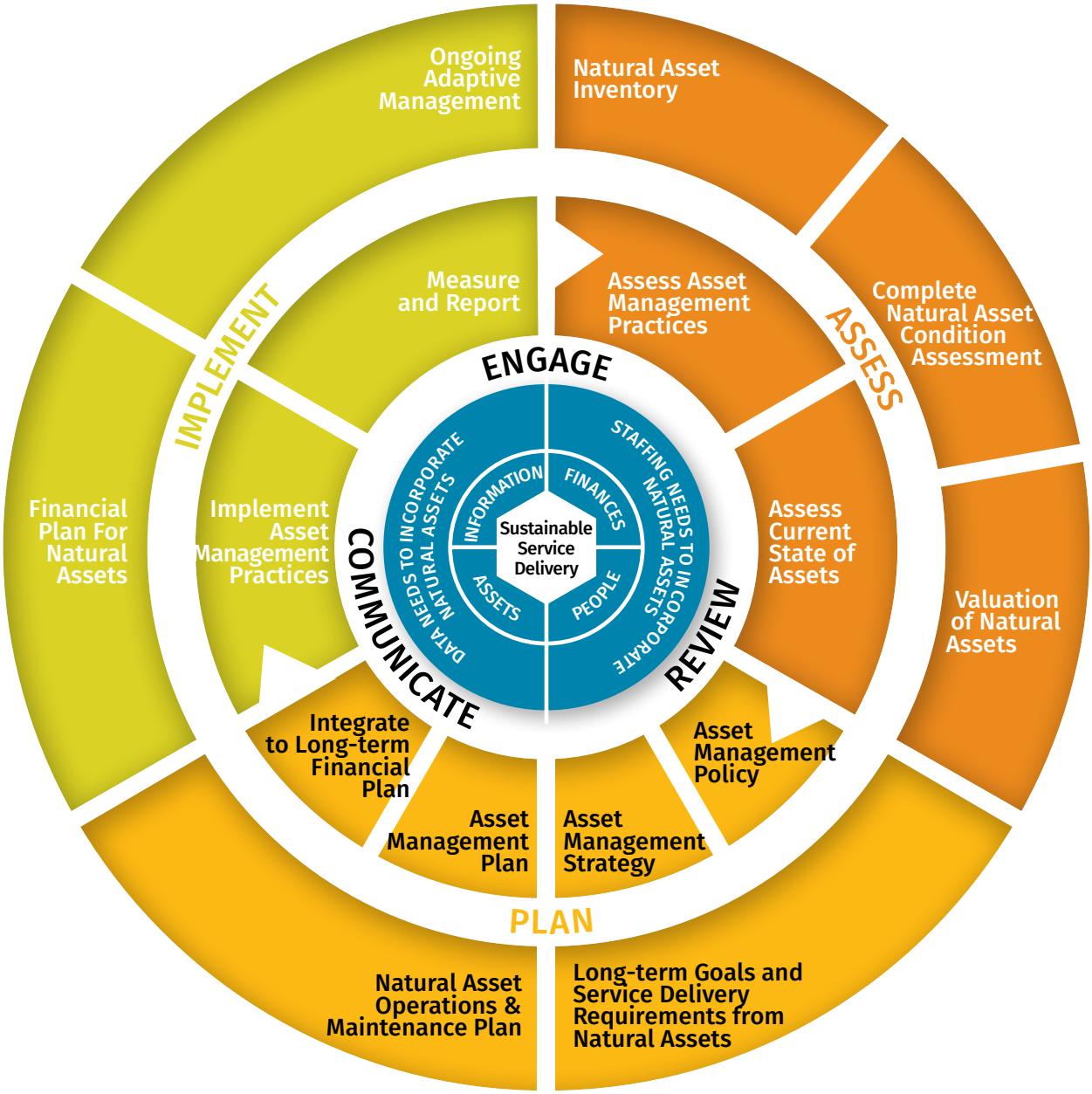

Figure 1: *The Asset Management Process. MNAI has adapted this for use with natural assets.*

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

3 Local government context

3.1. General

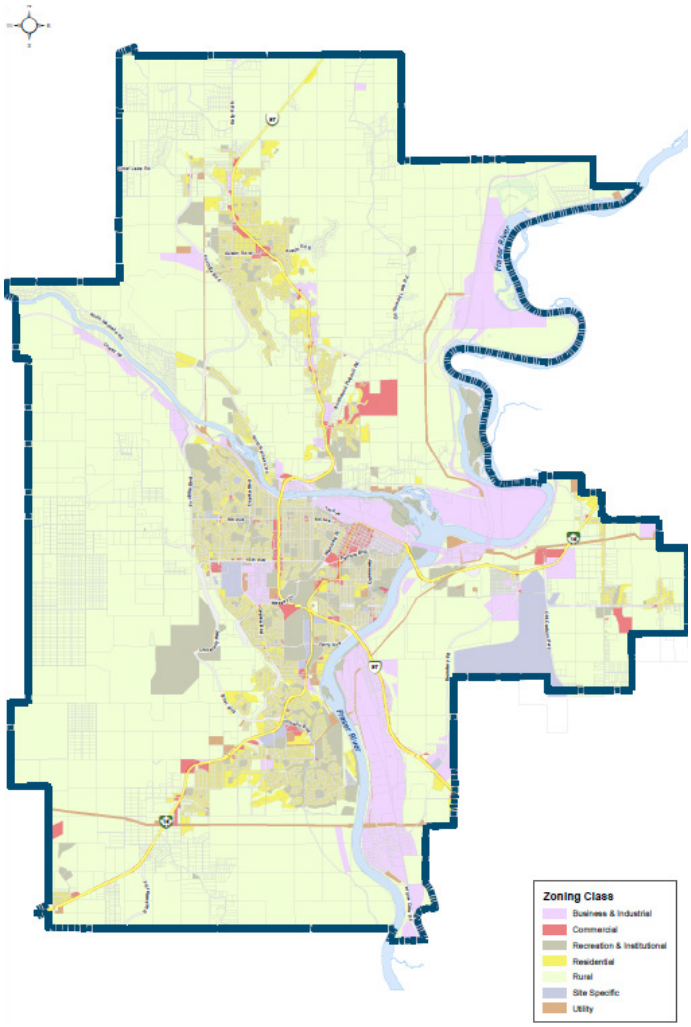

Figure 2: City of Prince George

The City of Prince George (population ~86,000) is in northern British Columbia at the confluence of the Fraser and Nechako rivers[3]. Prince George has three main interests in natural asset management. First, it wants to understand what natural assets they own and rely upon and what services these provide to the community. This understanding will help Prince George better manage and protect the natural assets; for example, it could mitigate drainage issues resulting from large-scale tree removal. It could also help Prince George obtain sufficient funding for maintenance and/or protection of natural assets.

Second, Prince George has identified greenfield development pressures as a threat to its natural assets. Completing an inventory as a first step towards natural asset management will help Prince George respond to the impacts of development by identifying what natural assets exist now and therefore need to be preserved or reinstated after development. For example, the Development Services department is considering expanding Development Permit areas to include not only riparian and aquifer protection considerations, but natural asset ones also; the inventory could support this endeavour.

Third, this exercise could shed light on the importance of natural assets in climate change adaptation and mitigation. Prince George's 2020 Climate Change Mitigation Plan identifies the importance of preserving the natural environment, planting trees, and restoring forests and wetlands to lessen the impact on the climate. The Climate Change Adaptation Strategies for the Community of Prince George 2020 identifies protecting natural assets and enhancing ecosystem services as one of its key goals.

Broadly, Prince George identifies aquifers, trees and wetlands as the priority assets. Groundwater aquifers for drinking water, wetlands adjacent to sanitary sewer lagoons for the discharge of treated water, and stormwater management are high priority services of concern for Prince George. Natural assets are

3 *Retrieved March 4, 2021 from www.princegeorge.ca/Business%20and%20Development/Documents/Planning%20and%20Development/OCP/OCP_Monitoring_Report.pdf*

conceptualized within Prince George's Watershed Drainage Plans through the sensitive ecosystem inventory (SEI) and terrestrial ecosystem mapping (TEM). The climate change projections predict rising annual temperatures and hotter summers which will impact the health of aquatic systems, grasslands and forests. It is also expected to exacerbate the risk of wildfire and pest infestations, decrease soil moisture, increase irrigation demands and the need for salting roads.

As a result of climate change, precipitation is expected to become more extreme and may overburden the stormwater systems and lead to increased flooding, slope instability and erosion. Prince George's Official Community Plan recognizes the relationship between the natural and built environments related to integrated stormwater management and water protection. Prince George is currently developing an Integrated Stormwater Management Plan that will include best management practices for natural assets and identify where they can be used instead of, or as a complement to, engineered infrastructure.

Prince George's asset management system is integrated into the organization at every level and includes cross-functional committees governing its actions. Its Asset Management Policy, Strategy and Roadmap identifies the importance of the role that natural assets have in relation to climate change adaptation and mitigation. Prince George aims to either incorporate natural assets into their corresponding service categories or have a stand-alone natural asset management plan.

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[4] 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.

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

Prince George is at an intermediate stage of adopting asset management in most areas and making progress towards a fully integrated asset management system. It has a high level of competency in the people and leadership category. Its cross-functional asset management team has well-established roles and responsibilities that have been operationalized across the organization. The team guides and supports the integration of natural asset management in its asset management system.

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

Prince George has an asset management policy and policy objectives for natural assets that are starting to guide its actions. Prince George also considers natural assets in its approach to climate change adaptation and mitigation.

Prince George has a roadmap guiding the actions called for in its asset management strategy. The strategy and roadmap include objectives related to natural asset management and show how it will be integrated into core infrastructure management processes over the next five+ years.

Prince George monitors the progress of its asset management system based on how many roadmap items they complete each year. It has also recently developed customer and technical levels of service measures. Some measures are already established in its Computer Maintenance Management System (CMMS)[5] while others will be implemented in the next three years. Prince George has been using its CMMS, Cityworks, for seven years. This platform ensures the operations and maintenance of Prince George's assets is recorded, analyzed, and prioritized. The intention is to build the natural asset inventory into this system.

To-date, Prince George has identified short-term actions that incorporate natural assets into asset management including Terrestrial Ecosystem Mapping (TEM) and developing a Sensitive Ecosystem Inventory (SEI); it will also create inspection templates for natural assets.

For data and information competency, Prince George is quite advanced (level 4). It has basic inventory data for all engineered assets, with some level of service information and standardized condition ratings. Life cycle investment requirements have been determined for critical assets and asset management and financial information for critical assets are linked. This information is conveyed in an Infrastructure Report Card that Prince George has had embedded in its Financial Plan since 2019.

Prince George has some information on the condition and performance of at least one critical natural asset based on a combination of online data collection, field data collection, and modelling (e.g., SWMM for storm water management performance). It identified natural asset valuation as a potential action for improvement.

Asset investment planning currently combines structured and ad hoc approaches. Each department is responsible for conservation and protection of natural assets, but they are not typically included in asset investment planning or evaluated in relation to the municipal services provided. Prince George identified the need to include natural assets as an asset category in its Asset Management Plans; for example, to ensure aquifers are included in its Water Infrastructure Asset Management Plan.

5 *en.wikipedia.org/wiki/Computerized_maintenance_management_system*

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 Prince George 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

MNAI used the most recently available annual crop inventory data produced by Agriculture and Agri-Food Canada (AAFC) as baseline for land use / land cover.[6] MNAI then combined this spatial data with data the municipality provided on wetlands and water bodies 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
Hydro Line 2014	City of Prince George Open Data	Identify length and presence of hydrological features in and around natural assets
Hydro Poly 2014	City of Prince George Open Data	Identify extent and presence of hydrological features in and around natural assets
AAFC Crop Inventory for BC 2019	AAFC Crop Inventory - Open Government Portal	Used to compare landcover types with Vegetation Resources Inventory (VRI) data to ensure accurate reclassification of vegetation polygons when necessary
DRA Digital Road Atlas	iMap BC	Used to assess the Road Density
Vegetation Resources Inventory (VRI) Vegetation Polygons	iMap BC	Used as the base file to construct the natural asset inventory and to assess the impact of adjacent landcover types on natural assets
Community Forests	City of Prince George Open Data	Used to estimate area of assets covered by community forests
Storm Catchment Areas	City of Prince George Open Data	Used to assign information on which storm catchments are associated with which natural assets

6 *For more information on AAFC annual crop inventory, see: Annual Crop Inventory - Open Government Portal (canada.ca)*

TABLE 1: DATA SOURCES SUMMARY		
DATA	**SOURCE**	**PURPOSE**
Ownership Data	iMap BC	Used to split and assign natural assets with information on the different owners and management
Study Area	Provided by Prince George	Used to limit the extent of other datasets to boundaries of the study area

The inventory project defined a total of 20,701 individual assets, covering 25,755 hectares (ha) of the municipal area, as noted in Table 2. The majority of this area was forest cover, followed by shrublands.

TABLE 2: SUMMARY OF NATURAL ASSETS BY TYPE			
NATURAL ASSET TYPE	**NUMBER OF ASSETS**	**TOTAL AREA (HA)**	**AVERAGE ASSET AREA (HA)**
Agriculture	501	1,701	3.4
Forest	18,498	21,009	1.14
Shrubland	1,169	1,714	1.47
Waterbody	503	1,280	2.55
Wetland	30	50	1.65
Total	**20,701**	**25,755**	**1.24**

4.3. Asset registry

Each asset within the inventory 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 on each asset is housed in an asset registry. An excerpt from Prince George's registry showing natural asset characteristics and details is in Table 3.

TABLE 3: EXCERPT FROM THE REGISTRY

Prince George, BC, Natural Asset Inventory | Summary | Asset Registry | Condition | Decomposition

Natural Asset Registry

Asset ID	Asset Type	Detailed Asset Type	Area (ha)	Length of Hydro Features within Asset (km)	Community Forest (ha)	Owner Type	Storm Catchment Name	Permeability Score	Relative Size Score	Adjacent Land Use Score	Road Density Score	Total Score
43228	Forest	Forest	0.20	0.36	0	None	Wright Creek	10	1	10	1	22
43228	Forest	Forest	7.01	0.36	0	Private	Wright Creek	10	1	10	1	22
53068	Forest	Forest	5.69	0.16	0	Private	Wright Creek	10	1	10	1	22
100700	Shrubland	Herb	0.10	0.00	2		Parkridge Creek	5	1	10	1	17
100700	Shrubland	Herb	4.46	0.00	2	Crown Provincial	Parkridge Creek	5	1	10	1	17
122955	Forest	Forest	0.25	0.00	0		Wright Creek	10	5	10	1	26
122955	Forest	Forest	17.92	0.00	0	Private	Wright Creek	10	5	10	1	26
138812	Forest	Forest	0.54	0.02	1	Crown Provincial	Beaverley	10	1	10	1	22
138812	Forest	Forest	0.91	0.02	1	Private	Beaverley	10	1	10	1	22
160651	Shrubland	Shrubland	0.46	0.34	2		Parkridge Creek	5	5	10	1	21
160651	Shrubland	Shrubland	11.48	0.34	2	Crown Provincial	Parkridge Creek	5	5	10	1	21
171844	Forest	Forest	11.86	0.07	16	Crown Provincial	Nechako West	10	5	10	1	26
171844	Forest	Forest	16.36	0.07	16	None	Nechako West	10	5	10	1	26
179313	Forest	Forest	13.17	0.00	0	None	North Nechako	10	1	10	1	22
191464	Shrubland	Shrubland	5.03	0.15	5	Crown Provincial	Nechako West	5	5	10	1	21
191464	Shrubland	Shrubland	5.03	0.15	5	None	Nechako West	5	5	10	1	21
191464	Shrubland	Shrubland	4.59	0.15	5	Private	Nechako West	5	5	10	1	21
208783	Forest	Forest	22.95	0.48	3	None	North Nechako	10	5	10	1	26
212674	Forest	Forest	0.45	0.19	0		Wright Creek	10	5	10	1	26
212674	Forest	Forest	10.85	0.19	0	Private	Wright Creek	10	5	10	1	26
216903	Forest	Forest	5.43	1.11	5	Crown Provincial	Otway	10	1	10	1	22
216903	Forest	Forest	1.97	1.11	5	Private	Otway	10	1	10	1	22
221003	Forest	Forest	0.34	0.00	0		North Nechako	10	5	10	1	26
221003	Forest	Forest	0.00	0.00	0	Crown Provincial	North Nechako	10	5	10	1	26
221003	Forest	Forest	0.00	0.00	0	None	North Nechako	10	5	10	1	26
221003	Forest	Forest	9.55	0.00	0	Private	North Nechako	10	5	10	1	26

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 is a screen shot from the dashboard that MNAI provided to Prince George. The full version can be accessed at *go.greenanalytics.ca/PrinceGeorge*.

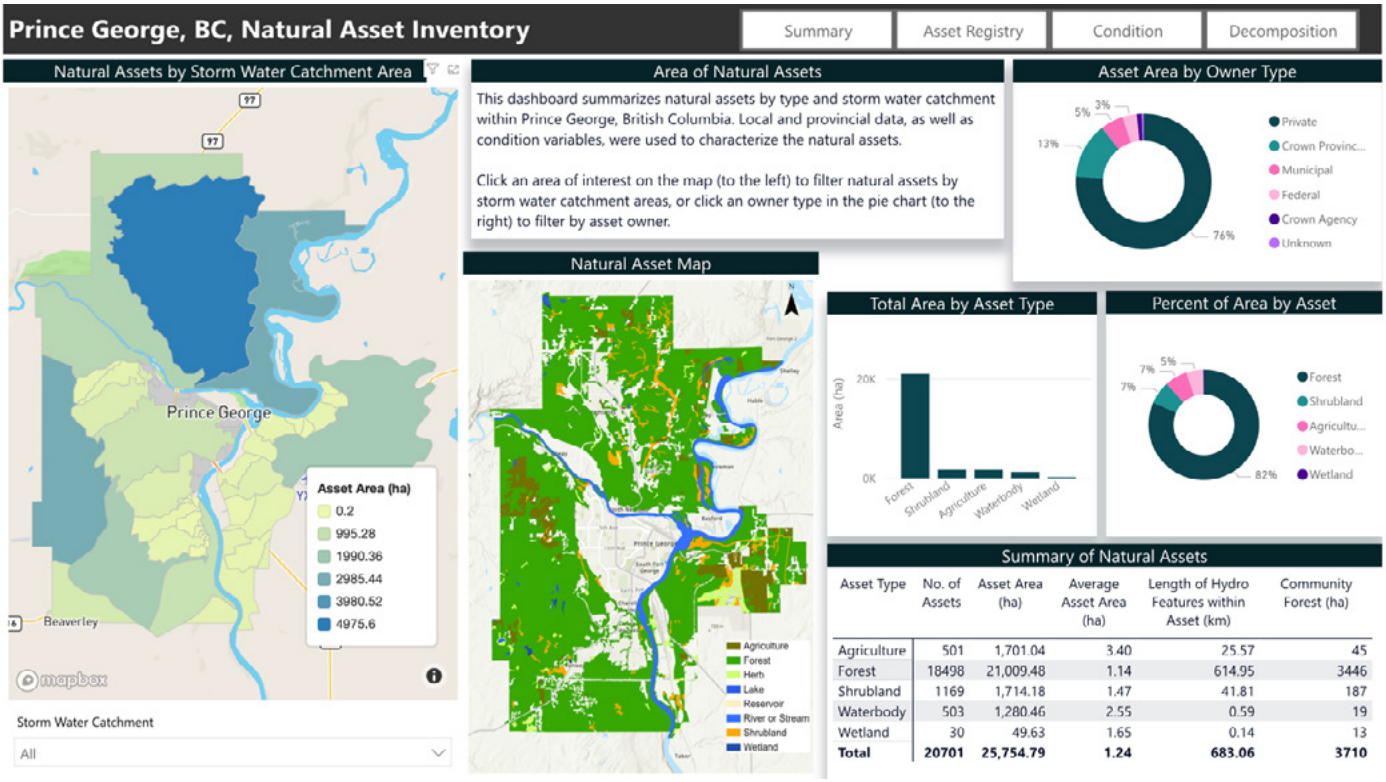

Figure 3: Screenshot of main inventory summary

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.

For Prince George, a desktop condition assessment was completed and built into the inventory to provide an initial understanding of the status of the natural assets for the municipality. The condition assessment steps and indicators are summarized in Table 4.

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. Recognizing that in most cases larger assets provide more services, 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*
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 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 4 is a screenshot of the condition assessment results for Prince George as depicted in the online dashboard.

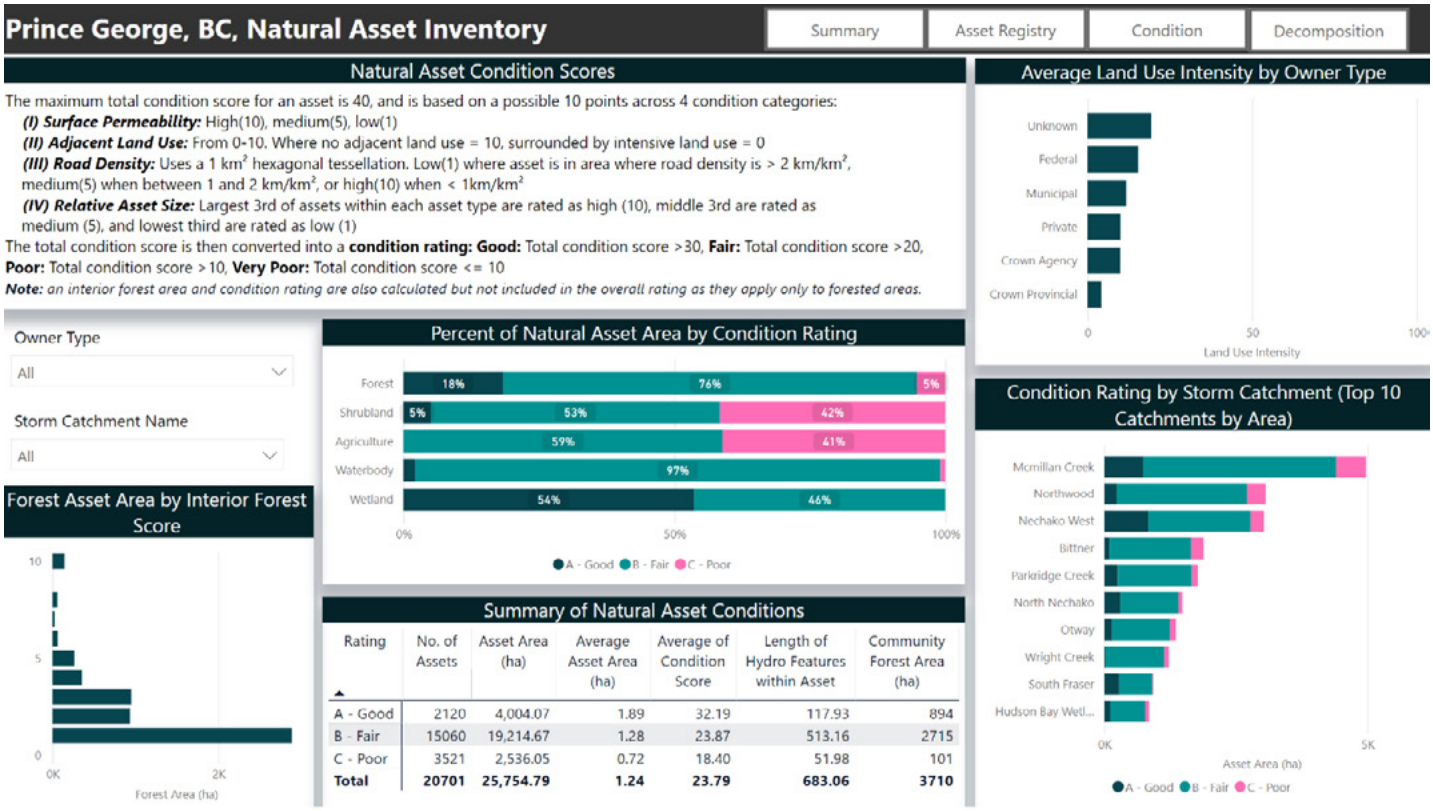

Figure 4: Snapshot of condition assessment details

About 4,004 ha (or 16 per cent) of natural assets were assessed in good condition and 19,215 ha (or 75 per cent) were assessed in fair condition.

Shrubland and agriculture assets were largely rated fair and poor. This is due to road density (in the case of the fair and poor ratings) and being relatively small (in the case of the poor rating). Note, however, that these assets only account for a small portion of the overall natural asset area (about 13 per cent combined).

The forest assets are generally in good or fair condition, as are wetlands.

Table 5 summarizes 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	Average Total Score
Good	2,120	4,004	1.89	32.19
Fair	15,060	19,215	1.28	23.87
Poor	3,521	2,536	0.72	18.40
Total	**20,701**	**25,755**	**1.24**	**23.79**

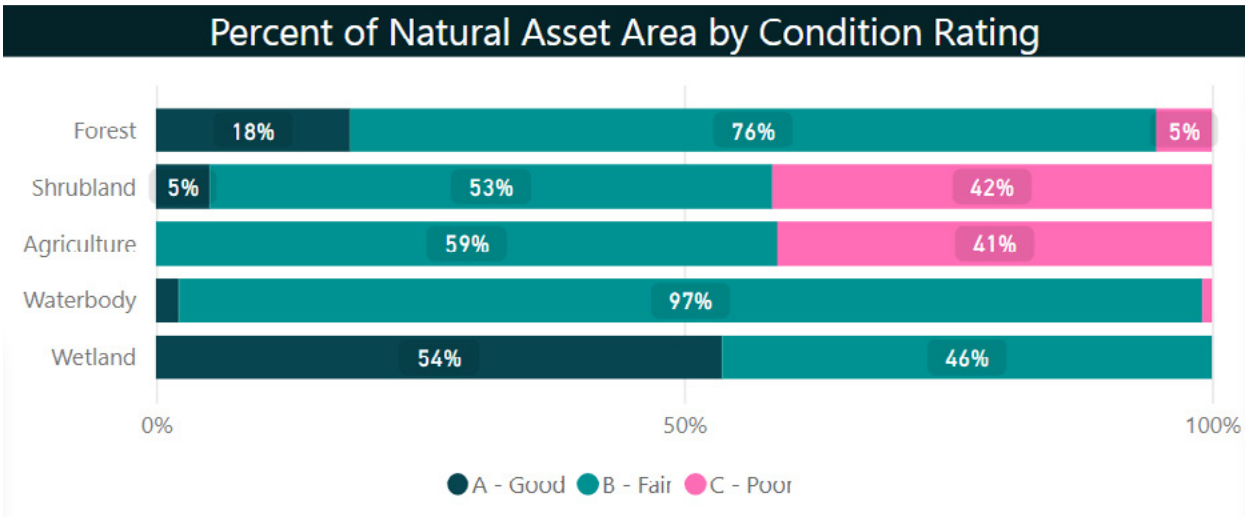

Figure 5: Summary of condition rating by natural asset type

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 Prince George 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, Prince George considered possible risks that the loss of natural asset functions could pose to built infrastructure, personal health and safety, and private property, including:

- Overuse of trails
- Illegal dumping
- Flooding (current and future for rivers and stormwater)
- Forest fire
- Interface fire
- Invasive species
- Development pressure (greenfield areas and developed areas)
- Pollutant loading
- Drought (current and future)

- Erosion
- Ice jams
- Lack of flood hazard mapping for urban creeks
- Lack of land management plans
- Construction activity
- Political policy change
- Bylaw legislation
- Climate change
- Marginalized camps
- Contaminated sites

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, Prince George 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 (riverine flooding, forest fire, greenfield development pressure, erosion, construction activity, and political policy change)
- 11 medium-level risks (illegal dumping, stormwater-related flooding, development pressure, pollutant loading, drought, ice jams, lack of land management plans, bylaw legislation, climate change, marginalized camps, and contaminated sites)
- 4 low-level risks (overuse of trails, interface fire, invasive species, and lack of flood hazard mapping)

The identified risks affect natural assets across the entire area within Prince George's boundaries but are of particular concern in the floodplains of the Nechako and Fraser Rivers, river banks, and in new development areas.

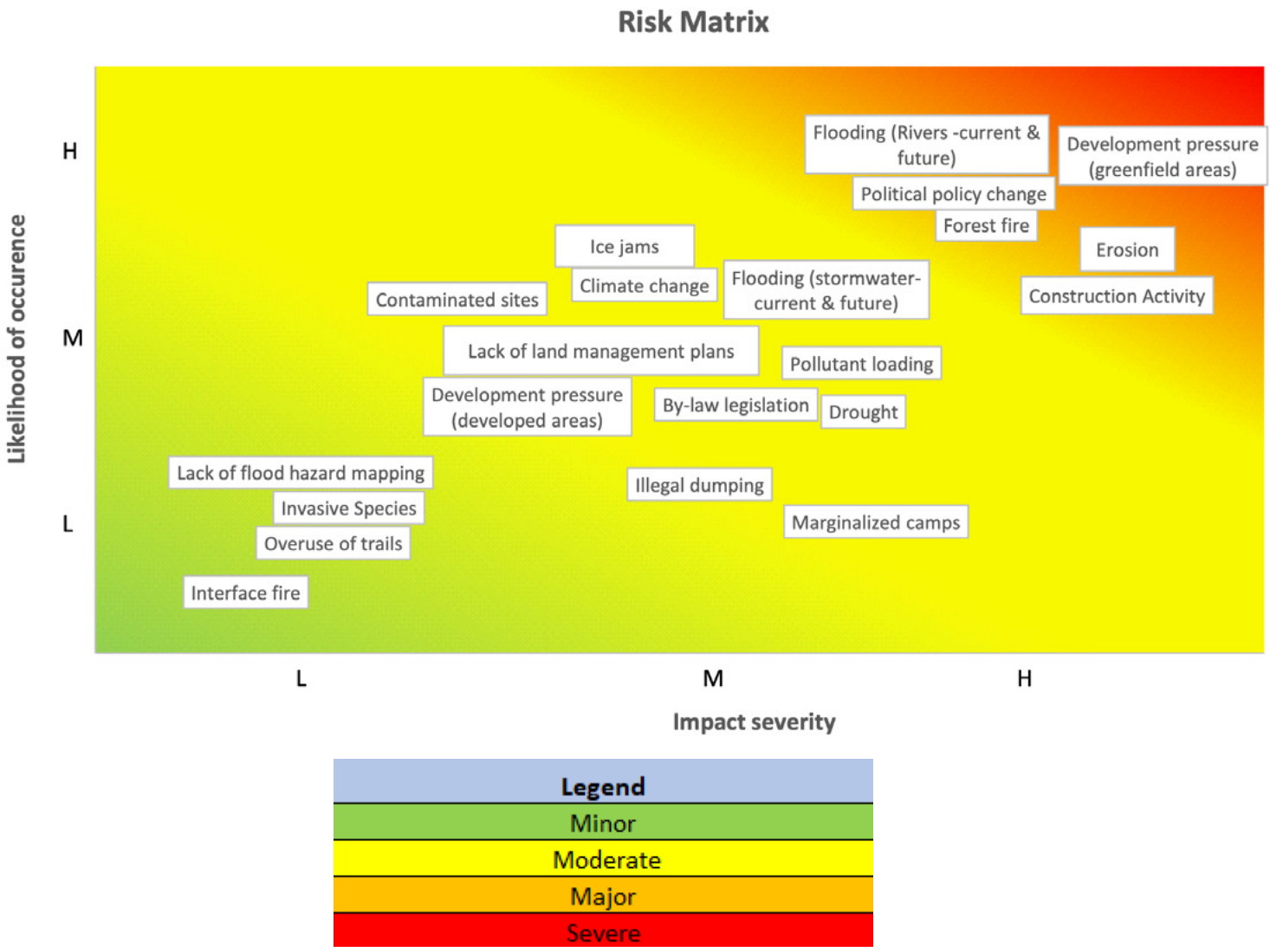

Figure 6: Results of risk management process

6 Implications

This section provides insights 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) issues the community 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 Prince George to focus their natural asset management efforts. These are as follows:

- **Riverine flooding:** Riverine flooding has been identified as high risk to forests, wetlands and river banks from seasonal spring freshets, a key driver for Fraser River flooding, and flooding from ice jams, which is linked to Nechako River flooding. The floodplains of the Nechako and Fraser Rivers, which include the storm water catchments of Bittner, Parkridge Creek, North Nechako, Otway, Northwood, Lansdowne, Ferry Ave, South Fraser, Brodman Creek, and Danson were identified as areas of concern. Prince George has completed a 3-phase flood project that included technical analysis, community input, and flood plain mapping[7]; this process resulted in a new Flood Plain Regulation Bylaw.
- **Forest fire:** Forest fire is of high risk and can impact forests, wetlands, agricultural lands, and shrubland. In particular, areas west of Prince George, as well as the areas of Malaspina, Broddy Road, Parkridge, Westgate, Piderney, Valleyview, Beaverley, Nechako West, Otway, North Nechako, Wright Creek, Northwood, and McMillan Creek were noted as being of concern. Many of these areas are difficult to access. Prince George has a Community Wildfire Protection Plan; however, this applies only to municipally owned lands. Therefore, additional measures could be considered such as fuel removal initiatives and controlled burns. Objectives related to this risk should be included in the next Official Community Plan, as well as Development Plans for private land.
- **Greenfield development pressure:** Greenfield development is encroaching on forests, wetlands, agricultural land and shrubland across Prince George. Such development can result in excessive tree removal and forest clearing, the removal of berms and swales, or residents redirecting creeks and wetlands. Effects may cascade and lead to other issues such as erosion and sedimentation and windthrow to remaining trees. Bylaw changes in the areas of grading and drainage, erosion and sediment control, and for natural asset buffers in new subdivisions could assist.
- **Erosion:** Erosion was identified as a high level risk to forests, wetlands, rivers, and agricultural lands in Northwood, the Hudson Bay Wetland, Peden Hill, Dornbierer, and Danson catchments. Within these catchments, areas along the river are at risk of erosion, land loss, sedimentation, degraded habitat for aquatic life, and increased flooding. While Prince George has mapped significant slopes with a 20% or higher grade, as well as erosion and sediment controls, stronger enforcement may be required to ensure measures are applied before vegetation is removed from soils[8].

7 *City of Prince George, 2009; City of Prince George, 2010.*

8 *City of Prince George, 2021.*

- **Construction activity:** Construction can pose as a lasting risk to forests, wetlands, agricultural lands and shrubland including impacts to groundwater zones, and increased levels of sedimentation, tree removal, sloughing, windthrow and runoff. Issues related to public versus private infrastructure and gravel pit extraction can be difficult to resolve. Natural asset management could help identify natural asset services that Prince George relies upon. This, in turn, could support evidence-based discussion, collaboration on appropriate management measures, for example, and updates to Environmental Development Permit Areas.
- **Political policy change:** Political policy change related to council changes, frequent zoning and Official Community Plan changes, and senior level regulations from the Province of B.C. have been identified as a very high risk to forests, wetlands, agricultural lands, and shrublands across all areas of Prince George. Prince George currently lacks an understanding of the value of the natural assets they rely on (which could extend beyond city-owned lands) to justify their maintenance. Moving to a full natural asset management project can help fill this gap and thus minimize this risk.

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

Following the development of the inventory, Prince George would like to build its understanding of natural asset service levels and include them in Asset Management Plans. It identified working with the GIS department to incorporate natural assets into the GIS system and building natural assets into its CMMS processes as potential areas of improvement.

Prince George identified possible next steps could include conducting a review of its regulations and design standards and identifying opportunities to update them. This could support climate change adaptation and mitigation goals, including flood mapping for urban creeks and alternative design using natural assets. Prince George is also interested in incorporating natural asset considerations into Environmental Development Permit Areas and enabling opportunities to protect natural assets in development by demonstrating the public benefit.

Prince George will continue implementing a Levels of Service development project, including community engagement. Public and internal web dashboards will communicate how Prince George and its assets are performing and if the current service levels are sustainable based on budget and resources.

Given Prince George's ambition to progress on natural asset management, another 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.

6.2. Possible actions for the further development of the inventory

Based on the inventory, Prince George 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 Prince George's risk mitigation strategies (see Table 6).
- Further develop the condition assessment and risk assessment 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.
- Share the inventory with adjacent local governments to stimulate collaboration.
- Examine how greenfield development, forest fire, pollutant loading, and political pressures could increase risk to assets.
- Develop improved bylaws and increase enforcement to direct greenfield development to suitable areas.
- 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 Prince George wishes to proceed with a full natural asset management project, including implementation, they would 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, the levels of service under different potential management and local climate change projections, and rehabilitation or restoration scenarios, are 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**. The natural asset implementation phase is an adaptive management cycle, not a finite journey. It is during this time that actions identified from 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 Prince George's risk identification

This Annex contains the results of the Prince George's use of MNAI's risk identification tool, which they self-administered with guidance from MNAI. Table 1 was the main product, developed by staff, 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/ Overuse of trails	L	Forest, Wetlands	All areas	Motorized vehicles using trails, crossing streams. More outdoor activities due to COVID-19. Damage from bicycle use. Vandalism, litter.
2/ Illegal dumping	M	Forest, Wetlands	All areas	Riparian areas are at high risk from grass clippings and compost, garbage attracting animals. Construction waste. Big problem on remote roads.
3/ Flooding (rivers -current and future)	H	Forest, Wetlands	Floodplains along Nechako and Fraser Rivers. Bittner, Parkridge Creek, North Nechako, Otway, Northwood, Lansdowne, Ferry Ave, South Fraser, Brodman Creek, Danson	High Risk in separate floodplain areas along rivers, map available on PGMAP. Seasonal spring freshet. Flooding from ice jams. Riverbanks should be considered assets also; loss of banks can be expensive.
4/ Flooding (stormwater – current and future)	M	Forest, Wetlands, Agriculture, Shrubland	Bittner, Parkridge Creek, North Nechako, McMillan Creek. Hudsons Bay, through Winnipeg and 15th drainage system. Cowart Rd. Graves area, golf course. Nechako West (Shane Lake Dam)	Infiltration from sanitary system. Agriculture runoff. Flood risk to neighbourhoods. Culverts, washouts, sinkholes. Carrie Jane Gray channel to the highway. Inundation zone for Shane Lake Dam. Risk on all Stormwater Inlets (Foothills), Erosion, roads get flooded, trees at risk.
5/ Forest fire	H	Forest, Wetlands, Agriculture, Shrubland	Malaspina, Broddy Rd, Parkridge, Westgate, Piderney, Valleyview, Beaverley, Nechako West, Otway, North Nechako, Wright Creek, Northwood, McMillan Creek	Community Wildfire Protection Plan, municipal land only. All areas high risk, difficult to access. All areas west of the City. OCP to be updated. Development plans, private land. Fuel removal project proposed. Projected wildfire projections (climate change). Controlled burns.
6/ Interface fire	L	Forest	All areas	Low risk in all areas for non-forest fires i.e., in urban treed areas or pockets, not 'forested' areas.

TABLE 1: SIMPLIFIED RISK IDENTIFICATION SURVEY

Risk	Ranking (L/M/H)	Assets Affected	Location	Notes
7/ Invasive species	L	Forest, Wetlands, Agriculture	All areas	Low risk in all areas. Transportation – roads, rail. Difficult to control on private property. Disturbed areas from construction or other digging are at risk. Domano and other wetlands. Boats in the water transfer species. Soil storage locations.
8/ Development pressure (Greenfield areas)	H	Forest, Wetlands, Agriculture, Shrubland	All areas	Bylaw/enforcement deficiencies. Bylaw updates needed. Encroachment from development. Grading and drainage not being done well, sediment concerns. Too much tree removal. Windthrow to trees that no longer have cover. No roots for soil, erosion. Updates to erosion and sediment control language. Both residential and industrial. A lot of forest clearing going on. High impact developments. Existing infrastructure, people removing berms/swales or redirecting creeks, etc. New subdivisions.
9/ Development pressure (developed areas)	M	Forest, Wetlands, Agriculture, Shrubland	All areas	See above #8. Development pressure (Greenfield areas)
10/ Pollutant loading	M	Forest, Wetlands, Agriculture	All areas	Stormwater outfalls. Industrial areas. Just one stormcepter in the system (1st and River Rd). Parking lots, gas stations, car washes. CSP pipes themselves. Sediment loading. Salt/pre-treatment from roads. Spills in general. Nutrient loading from agriculture. WWTC and lagoons discharges to rivers.
11/ Drought	M	Forest, Wetlands, Agriculture, Shrubland	All areas	Mostly a future risk with climate change. Erosion, soil cannot retain water. Beetle affected trees. Cutbanks risk, high slope areas. Forest fire risk.

TABLE 1: SIMPLIFIED RISK IDENTIFICATION SURVEY

Risk	Ranking (L/M/H)	Assets Affected	Location	Notes
12/ Erosion	H	Forest, Wetlands, Rivers, Agriculture	Northwood (Cutbanks), Hudson's Bay Wetland, Peden Hill, Dornbierer, Danson	Significant slopes map on PGMAP. 20% or higher grade. Areas along river at risk of erosion, land loss. Outfall areas.
13/ Ice jams	M	Forest, River Banks, Bridges.	Cameron St bridge to Fraser River. North Nechako (Toombs Rd to city limit West). Hammond. Downtown	Yearly monitoring. Ice and water levels. Part of Emergency Management program. Sandbag distribution when needed. Possible damage to bridges.
14/ Lack of flood hazard mapping	L	Forest, Wetlands,	Parkridge, Bittner	Heavy rainfall or snow melt. All clay soil, overland flooding.
15/ Lack of land management plans	M	Forest, Wetlands, Agriculture, Shrubland	All areas	Zoning issues, rezoning. Updates needed to OCP, Neighbourhood plans, wildfire, parks. No lack of plans but enforcement is an issue. Old Sensitive Ecosystem Inventory and Terrestrial Ecosystem Mapping maps to be updated. Subdivision and Development Bylaw needs a revamp. Expand riparian protection areas. Lack of monitoring and reports. Searchable projects/ reports. Could use Cityworks Inspections.
16/ Construction activity	H	Forest, Wetlands, Agriculture, Shrubland	All areas	New developments. Public vs private infrastructure. What can we immediately control? Lasting risks, not just during construction. Groundwater zones. Ministry of Mines vs City Administration related to gravel pit extraction sites Sediment, tree removal, runoff from construction.

TABLE 1: SIMPLIFIED RISK IDENTIFICATION SURVEY

Risk	Ranking (L/M/H)	Assets Affected	Location	Notes
17/ Political policy change	H	Forest, Wetlands, Agriculture, Shrubland	All areas	Very high risk, frequent zoning changes. Political support, policy sets direction. Senior level of regulation from Province. Lagoon discharge regulations are becoming more strict. Council changes. Spills, justifiable tax-payer costs to cleanup and report. What value to put on natural assets for council? Money should be spent to maintain them. Agricultural zones, hard to tell them they cannot log their own land.
18/ Bylaw legislation	M	Forest, Wetlands, Agriculture, Shrubland	All areas	Specific tree clearing protection needed. Slopes – erosion, sediment, right to the rivers. Protection of stormwater ponds.
19/ Climate change	M	Forest, Wetlands, Agriculture, Shrubland	All areas	Monitor coming changes. Fire risk, flooding events. Cumulative impacts. Get buy-in from citizens.
20/ Marginalized camps	M	Forest, Wetlands, Shrubland	All areas	Mostly in downtown and in downtown green space areas. Homelessness issues. Fire, litter/ dumping, biological (blood, feces, needles, etc.) risks.
21/ Contaminated sites	M	Forests, wetlands, shrublands	All Areas – especially in the areas identified by Contaminated Sites BC - *www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/375_96_04#Schedule2*	Old gas stations, Claxton landfill. Known and unknown sites. Permitted sites. Spills. Regulations, classification, Schedule 2-Industrial / Commercial uses. By BC Hydro transformer sites.

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