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Towards a Two-Eyed Seeing Natural Asset Inventory for

Leq'á:mel First Nation

Natural Assets Initiative
MAKING NATURE COUNT

Summary of inventory results and recommendations

June 2025

Invest in Nature

The Natural Assets Initiative (NAI) is a Canadian not-for-profit that is changing the way communities deliver everyday services - increasing the quality and resilience of infrastructure at lower costs and reduced risk. The NAI team provides scientific, economic and ecological/environmental expertise to support and guide communities 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.

NAI works in partnership with local governments, Indigenous Nations, watershed agencies and many others, to move nature from the periphery to the core of decision-making. It does so by helping these entities to identify, understand, account for, and ultimately maintain and protect a wide range of natural assets (e.g., aquifers, wetlands, forests, foreshores) and the services that natural assets provide for communities. Natural asset management is a counterpoint to decades-long, business-as-usual approaches in which community services are delivered through engineered solutions alone and nature is excluded from investment, planning and land-use decisions except for narrow considerations like aesthetics, recreation or natural resource extraction to support local economies. NAI is dedicated to the development of tools and an emergent professional practice that seeks to account for the wide range of benefits nature provides in a community to support life (e.g., carbon sequestration, flood protection, air quality, clean drinking water, cultural revitalization and food sovereignty).

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This Project was led by a multi-disciplinary, multi-organization team:

Leq'á:mel First Nation
Mike Goold
Rick McKamey
Kilby Zeeb
Justin Laslo
Lisa Head
Tina Pederson
Morgan Lapointe

Natural Assets Initiative
Patience Cox
Kim Neale
Roy Brooke
Emily Sharma

Green Analytics
Amy Taylor
Jeff Wilson

Reciprocity Research Inc.
Dexter Robson

Dillon Consulting Ltd.
Jasmine Hunter

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Table of Contents


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1.0 Purpose

This report describes an initiative in which Leq'á:mel First Nation (LFN) and the Natural Assets Initiative (NAI) worked in partnership to create a natural asset inventory (hereafter, the initiative will be referred to as "the Project"). The Project had the followings objectives:

- Interweave Indigenous knowledge, worldviews, and perspectives into a natural asset inventory, and begin to embody a Etuaptmumk/Two-Eyed Seeing approach;
- Consider initial steps to design a natural asset management (NAM) program that can be used for watershed-scale decision-making, relationship building, and guardianship, to meet shared long-term ecosystem health goals while upholding Leq'á:mel Laws, Rights, Title and Jurisdiction;
- Develop both a Cumulative Effects Ranking (using the Province of British Columbia's cumulative effects values) and a Leq'á:mel Vitality Ranking (LFN values) that supports LFN decision-making within a portion of Leq'á:mel's territory (Figure 3) and gives confidence to Leq'á:mel citizens that their values and interests are being protected;
- Create an online map visualization tool that includes Leq'á:mel and Western Science knowledge for LFN staff; and,
- Provide all information from this project to LFN in an accessible and usable way that aligns with the principles of the principles of Ownership, Control, Access and Protection (OCAP).[1]

The Project Partners are made up of members from several organizations. LFN members comprised staff from the Lands Department and the Natural Resources Department, including experts in Referrals, GIS, Water, Forestry, Fisheries and the Guardians Program. NAI's multi-disciplinary team included technical assistance from Green Analytics. In addition, two organizations that had completed previous work with Leq'á:mel which was incorporated into this project, including Reciprocity, who had worked on traditional use

1 For details on the principles of OCAP, please visit *fnigc.ca/ocap-training*

and knowledge studies, and Dillon Consulting who assisted in the creation of Leq'á:mel's Land Use Plan.

The primary deliverable for the current project is a dashboard that provides access to a large database of primarily publicly available data and Indigenous Knowledge provided by LFN, for use by LFN to respond to referrals and to assist with planning work in the LFN territory.

Next steps to advance natural asset management in LFN are dependent on additional funding and are described in full in Table 5. At a high level the primary objectives following the completion of the dashboard are:

- Create an Indigenous (LFN) Valuation framework
- Develop a Natural Asset Investment Plan
- Create a Regenerative Natural Asset Plan
- Integrate LFN Community/Guardian Data into the database
- Create an Indigenous (LFN) Risk Identification System
- Identify mitigation strategies for core areas of LFN territoryt

photo credit: Dillon Consulting

2.0 Introduction

Natural assets management (NAM) is an evolving process that includes actions taken by local governments, watershed agencies and others to identify, value and account for natural assets in their financial planning and asset management programs, and develop forward-thinking, sustainable, and climate-resilient infrastructure.

NAM is a counterpoint to decades-long, business-as-usual approaches in which community services are delivered through engineered solutions alone and nature is excluded from investment, planning and land-use decisions except for narrow considerations like aesthetics, recreation or natural resource extraction to support local economies. NAM is based on standard asset management processes, which are comparable, replicable and thus can be scaled and applied across different contexts. NAM emerged as a primarily Western, science-based concept. As NAI has begun to work with Indigenous communities, it has recognized that NAM does not adequately encompass Indigenous ways of knowing and doing. Therefore, NAI is beginning to use Etuaptmumk/Two-Eyed Seeing to develop a process that embeds Indigenous knowledge and approaches into natural asset inventories and other aspects of NAM. This approach recognizes the interconnectedness of the natural environment, interweaves Indigenous knowledge and values, and is described in depth in Section 3.

A starting place in asset management—and thus the NAM methodology—is the development of a natural asset inventory.

What is a natural asset inventory?

Natural asset inventories provide details on the types of natural assets that are relied upon within the jurisdiction of a First Nation, regional government, local government or other entity. As depicted in Figure 1, 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.

Natural asset inventories have tended to include:

- **Natural asset types:** A list of natural features that provide services to the community, e.g., wetland, streams, forests, agriculture.
- **Ecosystem services:** A high-level understanding of the priority services natural features provide in the community, e.g., water filtration, flood protection/mitigation, food from agricultural activities, carbon sequestration and atmospheric benefits.
- **Condition and risk assessment:** An understanding of the present condition the natural features are in and the risks (both natural and human-caused) they may face.

All groups—whether First Nation, local government or other—are affected by at least some natural assets that are outside their traditional territory, or regional or municipal boundaries, thus potentially outside their jurisdiction. Therefore, the condition and risk aspects of the inventory recognize that some cumulative effects and risks have factors outside of the control of the entity developing the inventory.

Canada now has a voluntary Standard, published through CSA Group, that outlines minimum requirements and provides guidance to complete natural asset inventories.[2]

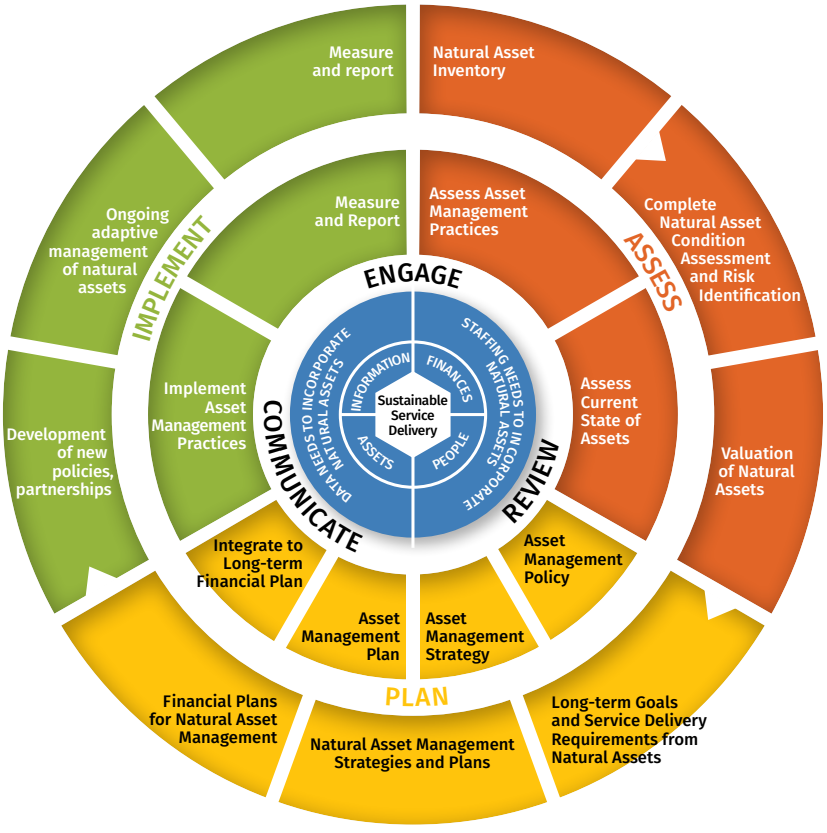

Figure 1: The natural asset management process (MNAI 2017), adapted from Asset Management BC's asset management wheel

2 Access CSA WS218 Specifications for natural asset inventories at www.csagroup.org/store/product/2430709/

As illustrated in *Figure 1*, NAM is an iterative, continuous improvement process. Following a natural asset inventory, communities have many options to deepen their understanding and integrate knowledge from the inventory into organizational and watershed level action; options for which there is a growing body of supporting tools, guidance and case examples, might include:

- Analysis of the people, governance processes and structures that support the ongoing monitoring, maintenance, restoration and enhancement of natural assets.
- Understanding staff and resources supporting natural assets in the watershed and what staff and resources may be required to maintain and improve these ecosystem services for the long-term.
- Undertaking valuations of the services provided by natural assets, determining levels of service, and developing investment and management plans.

This list of "beyond inventories" activities may differ in a First Nation context, as described in more detail below.

The focus of this Project was the development of a natural asset inventory to identify priority natural assets, and some related ecosystem services that LFN wants to collaboratively care for, monitor and enhance, employing a Two-Eyed Seeing approach where possible (see Section 3). How the inventory is used and applied will be up to the discretion of Leq'á:mel First Nation.

Evaluating risk, policy, governance, capacity, resources, valuation and investment plans are potential next steps in the NAM process that could be considered in subsequent phases. As NAI works with Indigenous Nations on developing these natural asset inventories, it will continue to incorporate and develop ways of natural asset management systems that have a foundation rooted in recognizing Indigenous ways of knowing, doing and being.

In addition, the principles of **Ownership, Control, Access and Possession (OCAP)**, which must be interpreted by LFN according to its values and belief systems, inherently incorporates the understanding that LFN has jurisdiction over any and all of its cultural knowledge, scientific data, oral teachings or any other form of data. (Ermine, Sinclair & Jeffery, 2004; Konczi & Bill, 2024).

photo credit: cc Kilby Zeeb LFN

3.0 Towards an Etuaptmumk/ Two-Eyed Seeing Natural Asset Inventory Approach

As noted, NAM began as a primarily Western, science-based approach. However, NAI is undertaking efforts to interweave Indigenous worldviews, knowledge and perspectives into their natural asset inventory, with the goal of helping NAM evolve to uphold Indigenous rights. For example, the report, The Journey So Far (Bear & Bill, 2023), describes NAI's initial efforts to develop a collaborative natural asset inventory with Treaty 1 First Nations and the Winnipeg Metropolitan Region, with facilitation from the Centre for Indigenous Environmental Resources (CIER) through the Collaborative Leadership Initiative.

Learnings from this experience led to the current Project, which received financial support from the Real Estate Foundation of BC. The ambition was to: build on the learnings from work with Treaty 1 First Nations; apply learnings from previous Western natural asset inventory projects; find ways to both center Indigenous knowledge and perspectives; and, be guided by existing and emerging concepts from Indigenous-led land, water and other natural resource protection best practices.

As an example of the latter, 'Etuaptmumk' is the Mi'kmaw word for Two-Eyed Seeing. This concept was brought to the forefront of Integrative Science by Mi'kmaw Elder Albert Marshall in 2004. The approach is often described as a way of learning to see from one eye with the strengths of Indigenous science and knowledge, and from the other eye with the strengths of Western knowledge and ways of knowing, and then learning to use both eyes together, for the benefit of all.

As work with LFN is uniquely guided by Leq'á:mel knowledge, the Two-Eyed Seeing approach operates within LFN's concept of Shxwelí, which is defined in Leq'á:mel interviews as the spirit and interconnectedness of all things. To evaluate (for the purposes of NAM) the lands and waters of LFN's territory using appropriate LFN ways of knowing, an understanding of how all things are

interconnected must be established. The use of a Two-Eyed Seeing approach uncovers more of these connections by expanding the lens in which these connections are made and creates a space that is more in-line with LFN ways of knowing.

To apply an Etuaptmumk/Two-Eyed Seeing approach, community partners must commit to creating an Ethical Space, a term coined by the Indigenous philosopher Willie Ermine from the Sturgeon Lake First Nation. Ethical Space engagement between two or more organizations, people or entities is a framework that examines the diversity and positioning of Indigenous peoples and Western society. In the 2018 report, We Rise Together, the Indigenous Circle of Experts (ICA) described ethical space as "avenue for collaboration and advice, sharing and cross-validation (where one side validated the other's decisions)". Ethical Space is about creating a place for knowledge systems to interact with mutual respect, kindness and generosity.

The Project agreement between LFN and NAI seeks to apply a Two-Eyed Seeing and Ethical Space approach to help NAM evolve by outlining Indigenous ways of knowing alongside Western approaches and creating a natural asset inventory that LFN can apply in collaboration with other First Nation and Crown governments, to enhance and protect watersheds.

Guided by these concepts, but also acknowledging that there is no accepted way to apply them in a NAM context, the following parameters were laid out for the Project and agreed upon with LFN:

- Ensure at least one First Nation is either leading the project or the First Nation is a clear partner with a local government in a common watershed and has the capacity/resources to participate in a meaningful way
- Uphold Indigenous data sovereignty by establishing clear guidelines for First Nation partners to retain ownership of the data shared to build a natural asset inventory
- Include Traditional Ecological Knowledge (TEK) and Biocultural Indicators (BI) in natural asset inventories based on data and information that is OCAP by First Nations.
- Grow Project Partners' shared understanding of ecosystem services and begin to develop a methodology for including TEK and BI in natural asset inventories—for example, initial priority TEK or BI ecosystem services could include food sovereignty, plant medicines, language revitalization, community wellbeing, restoration of Indigenous laws, and sacred, cultural and social gathering places based on data that a First Nation partner chooses to share.
- Build an initial shared basis of understanding amongst the Project Partners about the cumulative effects that have resulted in the present condition of the natural features.

- Understand the range of ecosystem services provided at a watershed scale and including all Rights-holders within a specified watershed. This is a counterpoint to natural asset inventories and approaches that are limited to geographical boundaries defined by colonial systems of government in Canada, which can have a practical but narrow focus on municipal boundaries that do not typically acknowledge watershed scale ecosystem thresholds or limitations.

For the initial phase of the Project, the study area considers LFN-identified critical watersheds that flow into the core of LFN territory (omitting the Stó:lō itself). These watersheds are central to Leq'ámel citizens' use of the lands and waters. This study area supports the health and wellbeing of Leq'á:mel citizens, as well as the plants and animals that call this area home. The study area captures 107 assessment watersheds based on the available Freshwater Atlas dataset. The study area is not representative of Leq'á:mel citizens' stewardship responsibilities to their territory and is only a portion of LFN's traditional territory.

Furthermore, Indigenous and non-Indigenous data, as well as approaches to managing data, were integrated into the inventory, as described in more detail below. The remainder of the report describes LFN's context, the work undertaken for the Project, the learnings and planned next steps.

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4.0 Community Context

Leq'á:mel First Nation takes their name from the Halkomelem language place name, *Leq'á:mel*, also known as Nicomen Island. Leq'á:mel is located on the Stó:lō (Fraser River) near present-day Deroche, east of Mission, BC. In Halkomelem, Leq'á:mel means 'flat or smooth meeting place,' referring to the flat lands and calm waters where up-river and down-river Halkomelem communities have traditionally met (Carlson et al., 2001). Leq'á:mel is geographically and culturally located at the center of the Halkomelem world. Based on LFN oral history, and consistent with understandings from neighbouring groups, Leq'á:mel is recognized as the birthplace of the Halkomelem language, with the term Halkomelem itself having the root word of 'lkomel' or Leq'á:mel, and meaning 'the language of the Leq'á:mel people'.

Today, LFN supports the ancestral stewardship responsibilities of the Leq'á:mel people, which includes descendants of historic nearby villages including Xat'seq (Hatzic) and Sxa'yeqs (Skayuks). LFN assert their rights, Title and responsibilities for their territory that includes:

> Everything above and below the land, as far as the eye can see from Leq'á:mel, south to the Nooksack River, east to the Harrison knob, northwest to the north short of Stave Lake, southwest to the northern shores of Alouette Lake and down the west side of Silver Creek (LFN Assertion of Title, 2017).

LFN is a signatory to the Stó:lō Nation, which consists of multiple Halkomelem-speaking groups united by the Stó:lō. At the time of writing, Indigenous and Northern Affairs Canada indicates that LFN has a total of 559 registered members including 414 off-reserve and 125 on Leq'á:mel reserves. An additional 12 members are living on other reserves. Member communities of the Stó:lō Nation work together on shared initiatives. Leq'á:mel First Nation sees itself as a self-governing entity within the Stó:lō Nation and has been a signatory to the Framework Agreement on First Nation Land Management since 2010 (LFN, personal communication, 2021).

LFN Chief and Council are elected according to the LFN Custom Election Code. LFN maintains nine core values: Integrity and Commitment, Teamwork, Trust, Leadership, Respect for the Land and Resources, Culture, Striving for Success, Taking Care of Each Other, and Careful Financial Management (LFN Chief and Council 2018). The LFN Council's mission and vision are as follows:

> **Vision:** "With knowledge gained from our past history, Leq'á:mel First Nation will strive to work in unity to create a healthy, safe, self-sustaining community where we will continue in our efforts to create a better future for our current and future generations" (LFN Land Use Plan 2015)
>
> **Mission:** "As the government of Leq'á:mel we are committed to working together to implement the strategic vision of the people by allocating resources, engaging citizens, and setting annual goals. We will make policy and decisions consistent with the strategic plan and Leq'á:mel culture and values. We will be transparent and accountable for our actions" (LFN Chief and Council 2018)

LFN's motivation for participating in the Project is to meet their stewardship responsibilities for their territorial lands and waters described in Halq'eméylem as S'olh temexw te ikw'eco xolhmet to mekw' stam it kewlat, meaning 'This is our land. We have to look after everything that belongs to us'. Leq'á:mel are working towards a future where a fulsome practice of Leq'á:mel rights and responsibilities is possible. This includes restoring the health of the lands and waters and improving the health and wellbeing of Leq'á:mel people so that future generations are able to conduct rights-based subsistence and ceremonial practices at levels consistent with those of their ancestors (Robson, Correia & Hodgins, 2025).

The Project provides a tool and approach that can support LFN in advancing better land use and landscape management decisions within their traditional territories, empowering their stewardship responsibilities. This, in turn, can support the assertion of their Indigenous rights. More specifically, and like many First Nations with limited capacity, LFN currently relies substantially on data developed and provided by others for their own purposes. Examples might include data provided by forestry or mining companies. By contrast, if LFN can amalgamate Western and Indigenous data sets into a system they design, own, and manage, they are better able to support their decision-making process, whether these be for leadership, the referral system or informing decisions within the Lands and Natural Resources Departments for projects, restoration and other Leq'á:mel priorities; one practical application would be to support a more efficient referrals process that serves the priorities of LFN (see box on page 11).

Dillon Consulting collaborated with LFN on the first phase of work for the Terrestrial Cumulative Effects Initiative (TCEI).[3] This began with preliminary community engagement efforts so that the future study would reflect the interests and priorities of the community, emphasizing the importance of community ownership in the success of TCEI. Dillon Consulting completed a preliminary background review to assist with the development of engagement materials and study parameters. Newsletters were developed and distributed to community members to raise awareness about TCEI and summarize key results of engagement to date. A questionnaire was distributed to solicit feedback and responses on areas of interests and priorities related to cumulative effects within LFN territory. Two open houses were hosted to provide an opportunity for participants to provide their specific feedback and input on TCEI Study ideas using interactive activities, in addition to the creation of a focus group with representatives from LFN to work with a smaller group of participants.

Dillon Consulting delivered a community pulse report on the results of the engagements. Key themes were summarized by water, intergenerational stewardship and access. Water is crucially important from its connection to creating a healthy community to concerns over invasive species and flooding. Participants shared having a sacred obligation to act as Caretakers for everything that belongs to us, on behalf of all generations, and viewing stewardship as an expression of sovereignty. Access to land and resources for Leq'á:mel people and wildlife was another common theme, particularly when looking to the past – the biggest factors influencing the state of LFN currently are related to the community's ability to access culturally and spiritually significant areas, as well as wildlife's ability to access areas critical for survival and reproduction. Language was identified as important to incorporate into the TCEI.

REFERRALS AND LEQ'Á:MEL FIRST NATION: A PROJECT DRIVER

Referrals are the process the BC provincial government uses as part of its 'Duty to Consult' First Nations when there are proposed developments in a First Nation's territory. Most development applications have this duty. Depending on the resources and uses of a First Nations territory, the number of referrals can vary significantly from community to community. The type of referral can range from what might appear as very simple, replacing a culvert under a road, to forestry plans for harvesting, and large industrial developments such as mines.

3 For more details on the TCEI, please see *www.canada.ca/en/environment-climate-change/corporate/transparency/strategic-environmental-economic-assessments/terrestrial-cumulative-effects-initiative.html*

The ability of a First Nation to respond to these referrals also varies.

Referrals are looking for permission to develop and often have significant technical information that is narrowly focused on the development. Referrals would not refer to any other development or address any cumulative effects associated with other development in that same area. Thus, it is up to the First Nation to understand the overlapping and potential consequences as it is not in the corporation's interest to identify those issues. The First Nation needs to figure out the potential long-term impacts to the lands, resources, traditional use areas and the community.

LFN has been working at collecting the data, stories and mapping to be able to respond to these referrals. In addition, LFN has been proactive with a Guardians Program in developing, cataloguing and creating traditional use protection and planning for water, fish, forestry, food and medicine harvesting, as well as culturally significant sites that are 'no-go' zones for non-Leq'á:mel people.

Supporting LFN's effective engagement in referrals is a significant project driver.

The Project can also support Leq'á:mel's environmental mission that speaks to Shxwelí as defined by Leq'á:mel Elders and knowledge holders as the spirit, and interconnectedness of all things.

> ***S'olh temexw te ikw'eco xolhmet to mekw' stam it kewlat.***
> *This is our land. We have to look after everything that belongs to us.*

The people of the Leq'á:mel First Nation are committed to protecting our environment and our way of living. We respect the interconnectedness of air, water and soil. We will be proactive, not reactive. We will use and develop our land in a sustainable and environmentally responsible way, taking a long view looking backward and forward seven generations.

The Leq'á:mel First Nation's environmental mission is to protect and preserve our culture and land. We will educate, understand, and learn for the betterment of the land and environment in which we all share. By engaging the community, all members take ownership of the responsibility to protect the land and enforce the rules of the community. This community of responsibility includes band members, past and future generations, tenants, invitees, and neighbours. We will ensure the protection of our land and culture 100 years or even 1000 years into the future. (LFN 2017a)

photo credit: cc Kilby Zeeb LFN

5.0 Natural Asset Inventory

The natural asset inventory developed for LFN has three main components: an asset registry (which is a tabular representation of the data); spatial data (geodatabase); and an online dashboard. This section of the report describes the approach used to define natural assets within the defined territory.

5.1 Inventory Approach

This subsection describes the steps to establish a natural asset inventory for the assets within LFN territory.

DEFINING THE SCALE OF ANALYSIS

The first step in designing the approach was to define the level of detail needed for the natural asset inventory. LFN and NAI decided that it would be based on the most detailed land cover land use data available for the study area. While the baseline inventory has been established to provide details of specific land cover features (e.g. forests, wetlands, aquatic etc.) , it was necessary to also consider a higher-level spatial unit of analysis. The unit chosen to define natural assets within the territory were "fundamental watersheds,"[4] the smallest unit of a watershed system within BC Freshwater Atlas' hierarchical watershed framework, and distinct from larger aggregations such as sub-watersheds, basins, or river basins. Figure 2 provides an overview of the asset hierarchy used to define natural assets, with the fundamental watershed being the highest level. Within each watershed unit natural, enhanced, and non-natural assets are defined, which are further classified by specific features.[5]

4 Assessment Watersheds are mesoscale aquatic units designed to replace the 3rd order 1:50K watersheds. Assessment Watersheds are based on groupings of fundamental watersheds using FWA

5 Watershed code and local code, with a target size of between 2,000ha and 10,000ha. Source: *open.canada.ca/data/en/dataset/97d8ef37-b8d2-4c3b-b772-6b25c1db13d0*

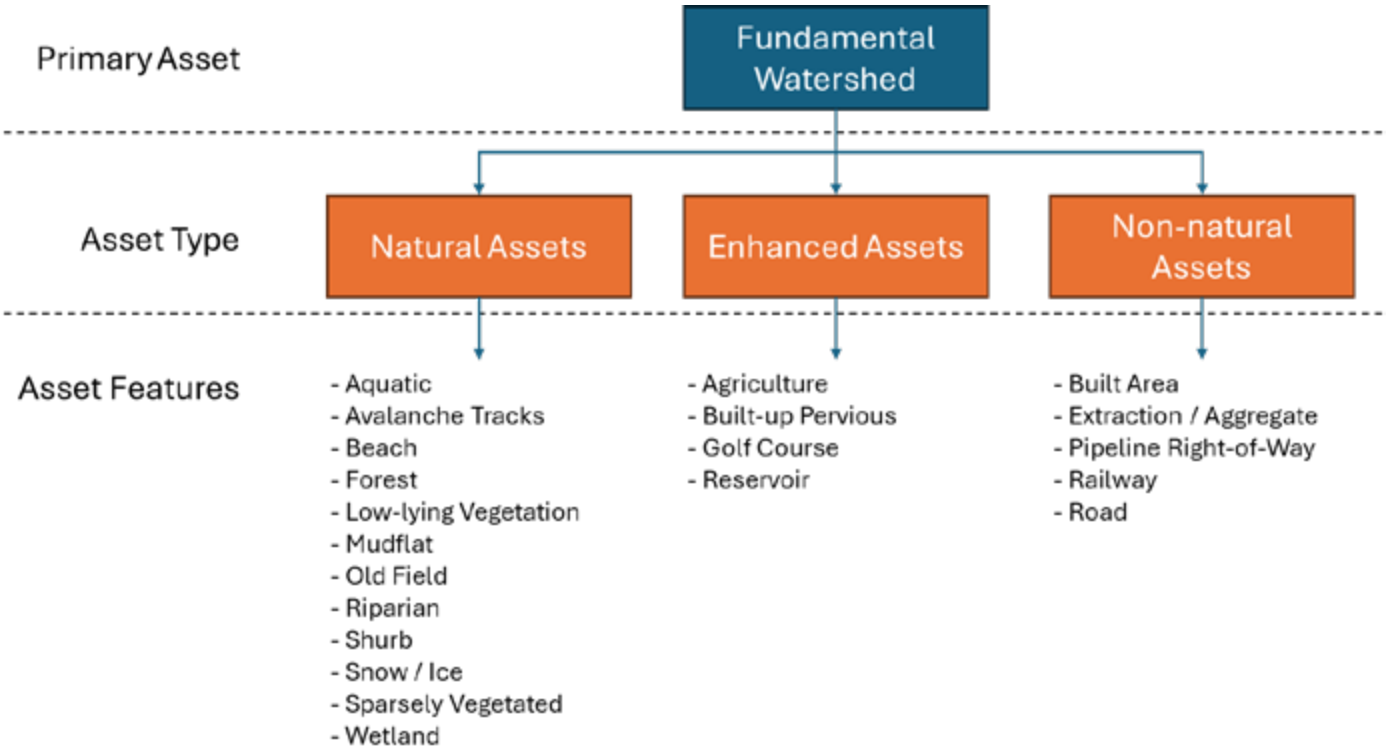

Figure 2: *Asset Hierarchy Used to Define Natural Asset Inventory*

This hierarchy was chosen for 2 main reasons:

- First, to assess natural asset condition; data to assess each feature at the finest possible scale (e.g., polygon) does not currently exist.
- Second, the large scale of the territory makes it impractical to assess assets on a site-specific level as there would be too many individual assets to consider in terms of decision-making and prioritize areas for improvement or protection.

Figure 3 depicts the fundamental watersheds for the territory.

Figure 3: Map of Leq'á:mel First Nation Study Area and Fundamental Watersheds

In summary, the structure of the natural asset inventory data allows for fine-scale resolution information to be captured, and higher resolution data to be employed for the purposes of analysis (e.g., condition assessment) or display. This approach also provides flexibility for LFN to store, utilize, and assess fine scale detailed information where available and applicable, while generating more aggregated outputs better suited to informing broader land use planning decisions when desirable.

DATA STRUCTURE

Figure 4 depicts how data was integrated to establish the natural asset inventory in a geospatial database, which can be thought of as the centralized location where the data is stored.

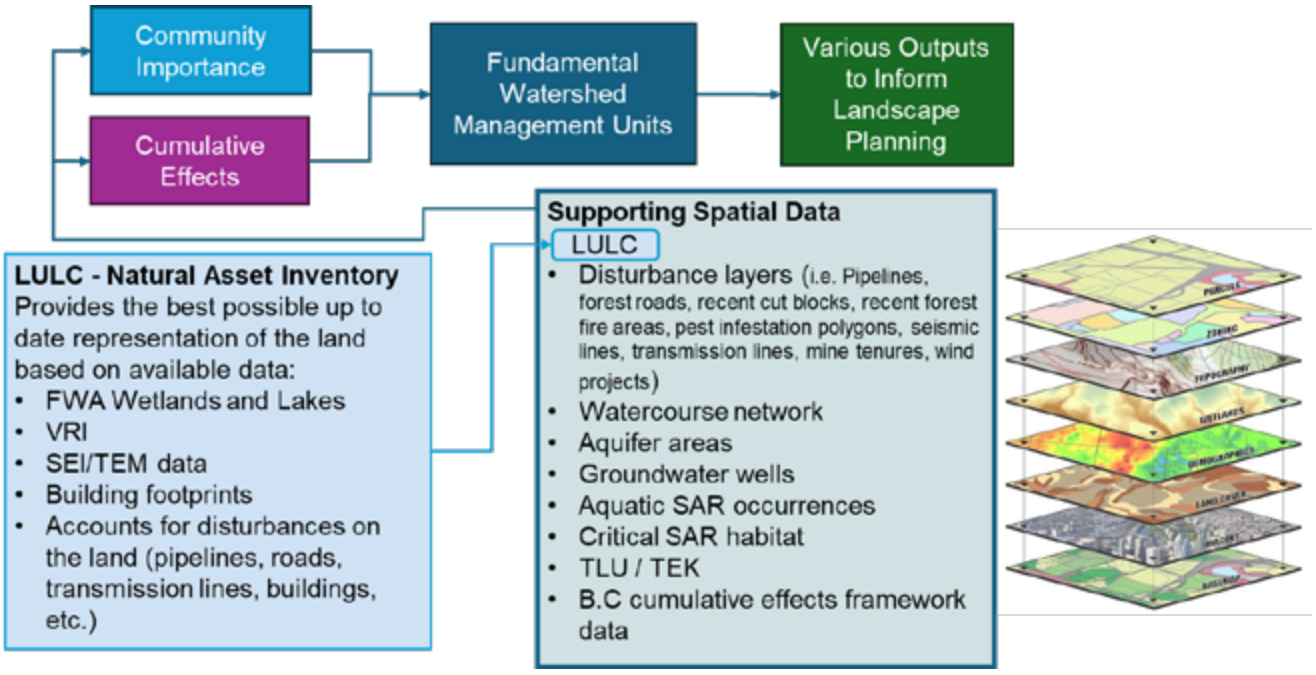

Figure 4: *Conceptual Overview of the Natural Asset Management Data Structure*

A key part of the geospatial database was the Land Use Land Cover (LULC) dataset, which combines information on how land is used (e.g. built-up or agricultural areas) with data on the physical material on the Earth's surface (e.g. forest or wetlands). Classifications are largely based on three data sets:

1/ Sensitive Ecosystem Inventory (SEI)
2/ Vegetation Resource Inventory (VRI)
3/ Freshwater Atlas (FWA)

Other data sources such the road networks and building footprints were used to "fine tune" the LULC data set to account for as much built land cover as possible. Figure 5 provides a summary map of the finalized LULC data, and Table 1 summarizes land cover within the asset hierarchy. Appendix A summarizes the available open-source data that was gathered and used throughout the project.

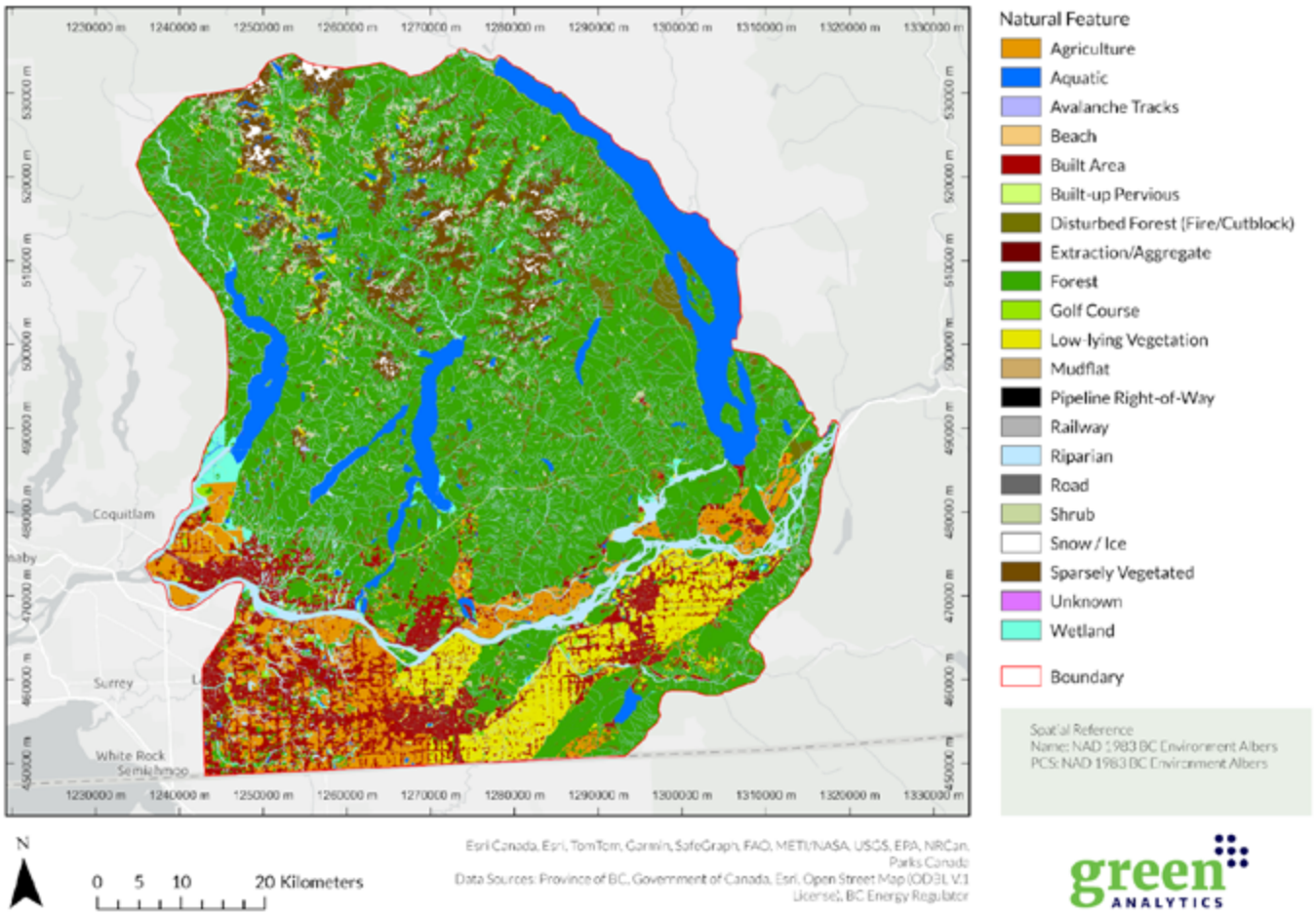

Figure 5*: Map of Leq'á:mel First Nation Natural Asset Inventory and Land Use*

Table 1*: Summary of Land Cover Types and Size in the Natural Asset Hierarchy*

Asset Type	Feature	Feature Type	Area (ha)
Natural	**Aquatic**	Lake	40419.75
		Pond	178.12
		Pond/Lake Sediments	6.97
		Reservoir Margin	19.53
		River Sediments	284.05
		River/Stream	13646.09
	Avalanche Tracks	Avalanche Tracks	74.41
	Beach	Beach	23.18
	Forest	Broadleaf Forest	28969.34
		Coniferous Forest	240605.23
		Mixed Forest	23709.41
		Parkland Forest	335.19
		Unknown Forest	1080.64
	Low-lying Vegetation	Herb	5416.45
		Herb - Forbs	45.79
		Herb - Graminoids	948.91

Asset Type	Feature	Feature Type	Area (ha)
Natural	**Mudflat**	Mudflat	101.43
	Old Field	Old Field	403.34
	Riparian	Broadleaf Forested High Bench Riparian Floodplain	36.13
		Broadleaf Forested Low Bench Riparian Floodplain	14.15
		Broadleaf Forested Medium Bench Riparian Floodplain	397.19
		Broadleaf Forested Riparian Fringe	501.79
		Coniferous Forested High Bench Riparian Floodplain	42.11
		Coniferous Forested Medium Bench Riparian Floodplain	4.38
		Coniferous Forested Riparian Fringe	1082.43
		Low Bench Riparian Floodplain	54.23
		Medium Bench Riparian Floodplain	0.77
		Mixed Forested High Bench Riparian Floodplain	51.96
		Mixed Forested Medium Bench Riparian Floodplain	55.89
		Mixed Forested Riparian Fringe	1560.03
		Riparian Fringe	35.27
		Riparian Gully	2004.57
		Shrub High Bench Riparian Floodplain	0.16
		Shrub Low Bench Riparian Floodplain	34.72
		Shrub Medium Bench Riparian Floodplain	43.02
		Shrub Riparian Fringe	126.38
	Shrub	Dwarf Shrub	1.20
		Shrub Low	9729.79
		Shrub Tall	9589.99
	Snow / Ice	Glacier	1092.01
		Snow / Ice	188.95
		Snow Covered	1122.63

Asset Type	Feature	Feature Type	Area (ha)
Natural	**Sparsely Vegetated**	Bedrock	22950.20
		Blockfield	311.23
		Cliff	16.28
		Cutbank	2.12
		Exposed Soil	257.00
		Moraine	715.15
		Rock / Rubble	1281.62
		Rocky Outcrop	161.99
		Talus	10092.64
	Wetland	Bog	436.70
		Fen	49.22
		Marsh	1837.73
		Shallow Water	452.35
		Swamp	2353.33
		Unknown Wetland	534.58
Enhanced	**Agriculture**	Agriculture	49357.62
	Built-up Pervious	Park	876.85
		Recreation Ground	15.51
		Rural Vegetation	1977.67
		Utility Corridor	524.10
	Golf Course	Golf Course	973.60
	Reservoir	Reservoir	89.70
Non-Natural	**Developed Area**	Airport	245.07
		Building	4542.76
		Built Area	15.74
		Landing	22.26
		Parking Lot	622.08
		Urban	38745.36
	Extraction/Aggregate	Gravel Pit	295.82
		Open Pit Mine	38.59
	Pipeline Right-of-Way	Pipeline Right-of-Way	220.07
	Railway	Railway	396.18
	Road	Road	7565.85
Unknown	**Unknown**	Other	0.57
		Unknown	41.64

5.2 Condition and Cumulative Effects Assessment

Information about the ecological health or condition of natural assets is vital to understanding the types and levels of services that natural assets provide, and the types of actions or interventions that may be warranted. For example, condition assessments can help users to:

- Assess and rank the relative condition of natural assets
- Prioritize areas for restoration or rehabilitation
- Monitor and track changes in land cover and condition overtime

The condition assessment conducted for the Project will support LFN in taking decisions related to landscape management and land use planning.

Natural asset condition assessments commonly use several indicators or metrics to assess the relative condition of a natural asset, and then rate it on a scale from very poor to very good. There is a degree of subjectivity involved in condition assessments in the sense that a natural asset could be rated as "poor" from a service provision perspective may not reflect the other historical, local, or inherent values that the asset supports. Indeed, in NAI's previous work described in Bear and Bill (2023), condition assessments were removed entirely from the analysis at the request of the Nations involved. Table 2 provides an example of the rating scale as outlined in CSA's natural asset inventory standard (CSA 2023).

Table 2*: Sample Condition Rating Scale Definitions*

Rating	Explanation
Very Good	Well-maintained, good condition, no signs of deterioration in ecological conditions. Natural asset service provision is high.
Good	Ecological conditions appear to be sufficient; some minor localized (or isolated) impacts noticeable, which might be a warning sign of possible decline. Natural asset service provision is acceptable.
Fair	Clear signs of deterioration in ecological function and service-influencing factors. Natural asset service provision, while still functional, is at risk of failing.
Poor	Condition is below standard with large portion(s) of the system exhibiting significant deterioration in ecological function. Natural asset service provision is impacted, and some services might be non-functioning.
Very Poor	Widespread signs of advanced deterioration; unlikely that the natural asset is providing any functional service.

For LFN, a condition assessment such as the one in Table 2 can be useful. However, applying natural asset management approaches to a large land base such as the Leq'á:mel study area also requires alternative considerations.

Specifically, to help inform broader LFN land use and landscape management decisions, the incorporation of cumulative effects considerations is also important. In the context of natural asset management, cumulative effects and asset condition are strongly related.

Cumulative effects refer to the collective impact of individual environments or ecosystems over time. Mahon and Pelech (2021) describe cumulative effects as the combined effects of multiple stressors on species or ecosystems over time and/or space, where stressors are all human-induced activities and drivers.

There are many approaches that can be used to inform and measure cumulative effects. They vary in complexity and scope ranging from qualitative approaches like questionnaires, interviews, checklists, matrices, and diagrams, to quantitative approaches like habitat suitability models, species stressor models, and simulation models (Mahon & Pelech 2021). The Province of BC has established a Cumulative Effects Framework (BC CEF) and has begun assessing and reporting on cumulative effects across BC.[6] The Province describes this framework as a set of policies, procedures and decision-support tools to help identify and manage cumulative effects consistently and transparently across its natural resource sector.

While natural asset condition assessment differs from a cumulative effects assessment, they are related and there is overlap in the metrics used. For example, geographic areas that are more disturbed (and therefore have higher cumulative effects) should have lower condition ratings, and areas of lower condition are likely to have reduced resilience and greater sensitivity to any additional impacts.

To help LFN better understand the condition of their natural assets and the level of disturbance on the landscape, the Project Partners identified indicators that could be measured with the data contained in the geospatial database that forms the basis of the natural asset inventory. To do so, the partners:

1/ Drew from typical natural asset management approaches to identify a suite of indicators that can be combined or stacked to rank the management units.

2/ Identified potential indicators from the BC CEF metrics.

3/ Selected indicators (from 1 and 2 above) to provide insights on the relative condition of each management unit and the degree to which each unit has been disturbed by industrial development and other natural disturbances.

6 See details on BC's Cumulative Effects Framework: *www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/cumulative-effects-framework/overview*

The indicators employed are as follows with each assessed in fundamental watershed:

1/ Density of watercourse crossings
2/ Road density
3/ Density of linear disturbances
4/ Equivalent clearcut area[7]
5/ Old growth forest
6/ Proportion of watershed area within 500 m of human disturbance

The Project team determined that a three-point rating system would work best scoring the indicators as either having either low, moderate, or high impacts. A detailed description of the approaches employed to measure each indicator are presented in Appendix B.

Finally, an overall cumulative impact metric was established by averaging each of the six indicators above and assuming an equal weighting. Figure 6 maps the results by fundamental watershed highlighting that much of the territory (94% - see Table 3) is already moderately or highly impacted.

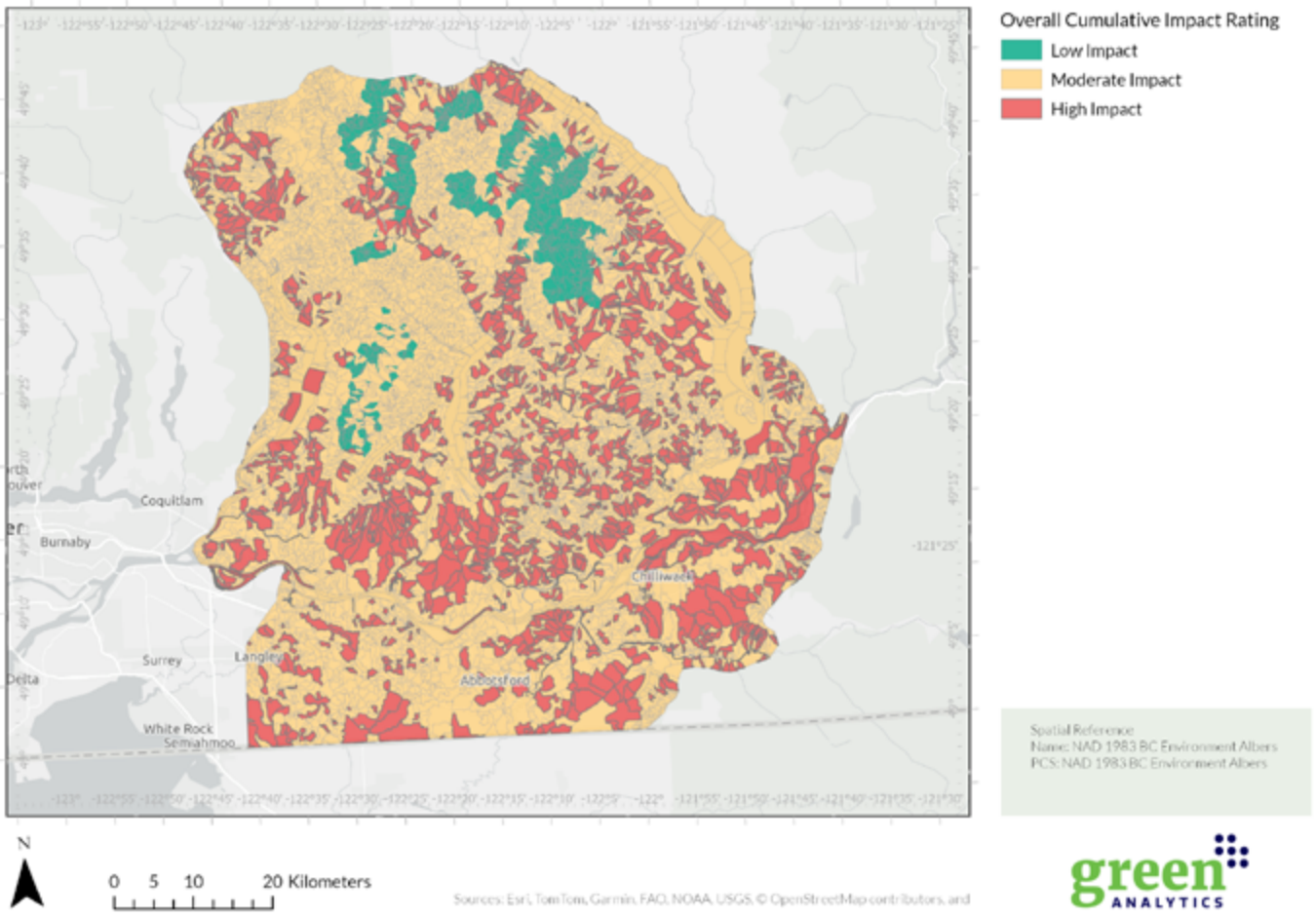

Figure 6: *Overall Cumulative Impact Rating Results*

7 Equivalent clearcut area factors in the area impacted by clear-cutting, area burnt by forest fires, and area impacted by pest outbreaks.

Table 3: *Cumulative Impact Ratings by Area (ha)*

Cumulative Impact Rating	Area (ha) of Territory	Percent of Territory
Low Impact	30,683	6%
Moderate Impact	366,830	66%
High Impact	157,095	28%
Total	**554,608**	**100%**

5.3 Community Vitality Measures

As part of this Project, and in line with the Project Partners' understanding of Two-Eyed Seeing, LFN has begun the process of developing a 'community vitality ranking'[8] that uses a similar formula to BC's cumulative effects calculation. This vitality ranking is informed by a rich spatial database of LFN knowledge documented through over half a decade of digital use and occupancy mapping interviews, Knowledge Holder workshops, and ecological knowledge studies. From this work, LFN have been able to identify an initial list of priority indicators that are most vital to Leq'á:mel citizens (see Figure 7).

Figure 7: *Priority Indicators Included in Leq'á:mel First Nation's Vitality Ranking*

8 The term 'community vitality ranking' was chosen to identify areas of Leq'á:mel territory (at the fundamental watershed level) that are most vital to Leq'á:mel citizens. Places Leq'á:mel citizens practice their rights, and the species and resources needed to support this. 'Vitality' was chosen over other options like 'importance' because it was felt to capture a sense of 'life' and 'the dependence on healthy systems' that a term like importance does not. This term needs to be verified with the LFN community during the next phase of this project.

These indicators are both based on important values (i.e., salmon and eulachon spawning areas), and areas of concentrated Leq'á:mel use, including:

1/ Number of LFN transportation routes intersecting the watershed management unit
2/ Number of LFN habitation locations within the watershed management unit
3/ Number of LFN environmental features within the watershed management unit
4/ Number of LFN Subsistence Sites within the watershed management unit
5/ Number of LFN Cultural/Spiritual sites within the watershed management unit
6/ Watercourse connection importance
7/ Wetland area as a percentage of fundamental watershed
8/ Ungulate survey observations importance
9/ Density of ungulate survey observations
10/ Ungulate winter range importance
11/ Eulachon spawning
12/ Salmon spawning
13/ Watershed fish diversity

The process of identifying these indicators was informed by previous community engagement through the studies mentioned above and verification with LFN staff. As part of this Project, these indicators were presented to both LFN staff, leadership, and community members through a workshop and community feast. Further work to refine the indicators using the feedback gathered as part of community engagement is expected to occur as part of Phase 2 of the Project.

Using these indicators as part of a community vitality ranking brings out areas that LFN have identified as most vital to the practice of their rights (Figure 8). The Project Partners adjusted the 'weights'[9] of these indicators, and the sensitivity of the ranking scale to where major waterbodies could be identified. In Figure 8 below, waters flowing into the Stó:lō River including the Stave, Alouette, and Hatzic watersheds are visible. The Stó:lō is highlighted as most vital to Leq'á:mel citizens as anything that impacts the Stó:lō (industry or otherwise) will have far-reaching and cumulative effects on the core of Leq'á:mel's territory. Examples of these effects, and why indicators related to fish were chosen as priority, comes from Leq'á:mel Knowledge Holders. Below are transcripts of the feedback provided by Knowledge Holders during the workshops.

> *...So today eulachon doesn't come up the river any further past Kwantlen and Katzie due to the changing climate, the increased buildup of sediment, increased competition with predators such as seals... essentially Kwantlen and Katzie fishes eulachan for everybody... (L09, September 7, 2023)*

9 The weighting of these indicators as part of the community vitality ranking calculation should be reviewed as part of a technical staff and knowledge holder focus group.

... Our traditional ways, is that the more you give away, the more wealthy you are, right? You can host someone and have a gathering, and the more you give away, then more will come back to you. It's just a different system in how you think. But nowadays, we have, we depend on- money and we depend on economics to even survive and live, like we can't just go walk out and go shoot a deer in our backyards anymore, right? Or go catch a salmon when we want to. We have to go to the grocery stores now, right? So there's impacts that way too. –L36 , November 27th, 2024

Leq'á:mel is experiencing declines in the critical resources that are most important to the practice of their rights, and Leq'á:mel identity. It is the hope that by including a community vitality ranking as part of this work, LFN can make informed decisions around prioritizing areas for protection and restoration that better align with community values related to the lands and waters. Referencing Table 4, the most vital watersheds make up 11% of the study area. This provides a basis for LFN to focus decision making considerably on the areas most important to Leq'á:mel citizens and the resources that support Leq'á:mel identity.

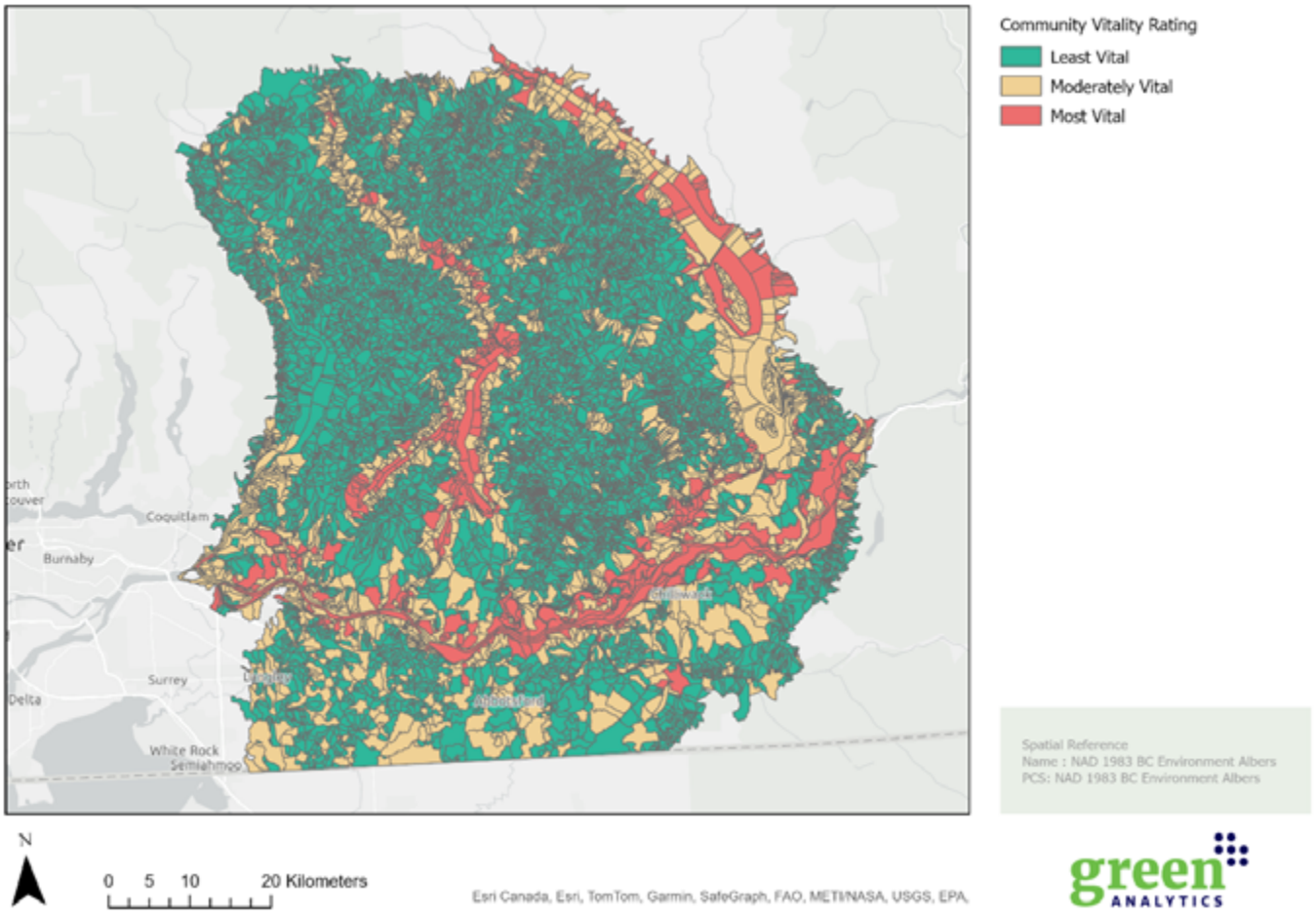

Figure 8: Map of Most to Least Vital Areas Per the Community Vitality Ranking

Table 4: *Community Vitality Rankings by Area (ha)*

Community vitality Rating	Area (ha) of Territory	Percent of Territory
Least Vital	341,862	62%
Moderately Vital	151,814	27%
Most Vital	60,933	11%
Total	**554,608**	**100%**

5.4 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 location or asset type. Figure 9 is a screenshot from the natural asset inventory dashboard. The full dashboard is owned and used internally by Leq'á:mel First Nation.

Within the dashboard, various filters are accessible throughout the different sections of the dashboard. Filtering allows a user to create custom subsets of data based on a selection of attributes within the natural asset inventory dataset.

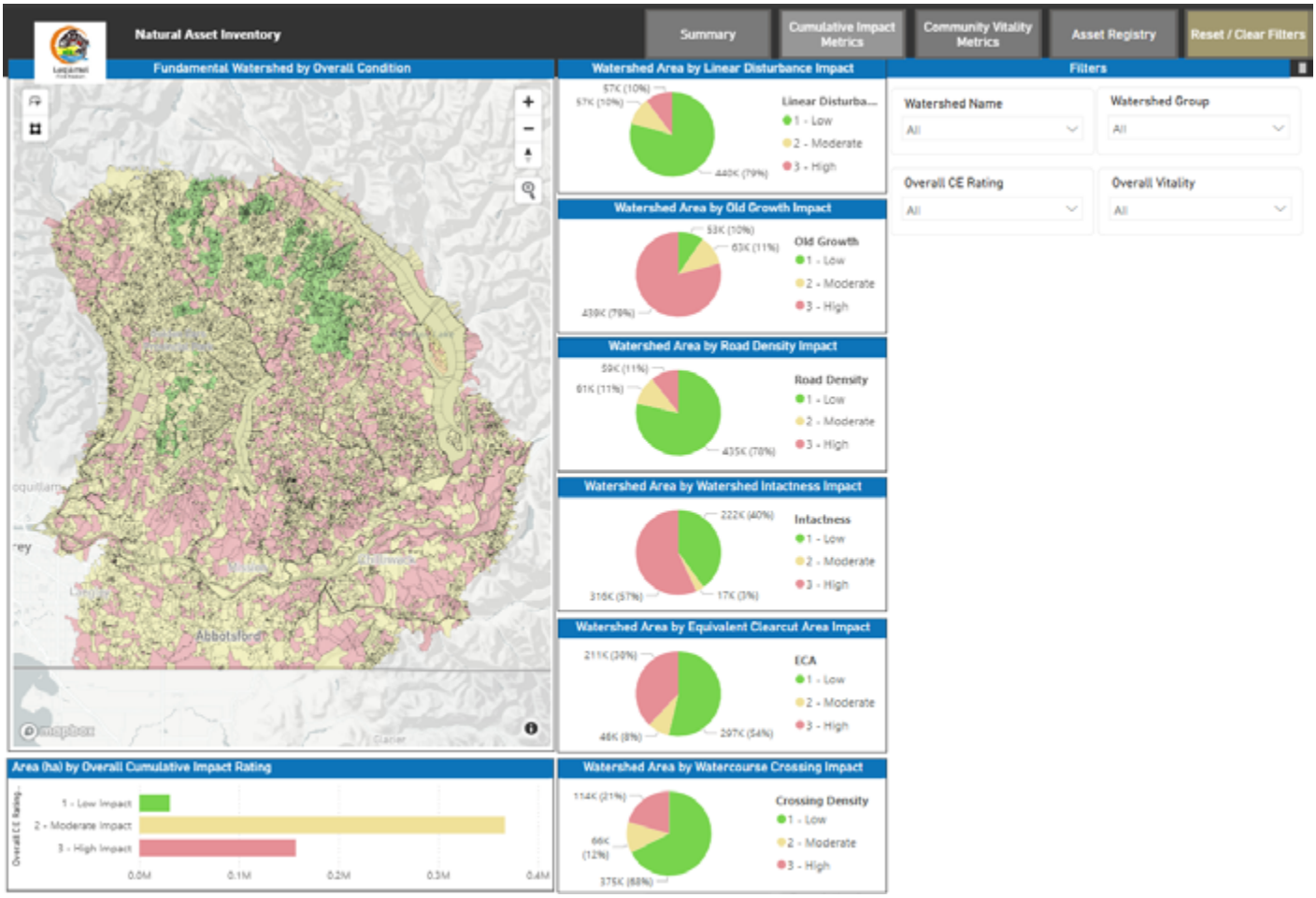

Figure 9: Screenshot of Cumulative Impact Summary from the Online Dashboard

5.5 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.


photo credit: cc Kilby Zeeb LFN

6.0 Learnings

The Project has resulted in a natural asset inventory that can support LFN in taking and/or advancing better land use and landscape management decisions within their traditional territories and, ideally, support their ancestral and ongoing stewardship roles and the upholding of Indigenous rights.

LFN will determine how best to use the inventory. The primary advantage to having the information collected into the inventory is that LFN can create reports on specific areas that align with their priorities and can include recognition of traditional use where that information is available. It should be noted that in areas where there are not traditional use studies currently does not mean that area was not used for traditional activities; it simply means that information has not yet been collected or is not being shared for that area.

Throughout the Project, LFN consistently brought efforts back to the original concept of Etuaptmumk/Two-Eyed Seeing, and reminded all Project Partners what, how, and most importantly why this work is being undertaken. The Project should therefore be considered to have made a practical and tangible initial contribution to Etuaptmumk/Two-Eyed Seeing by piloting the approach in a NAM context.

Much has been achieved through the process, in particular:

LEQ'Á:MEL FIRST NATION LEARNINGS

Leq'á:mel First Nation is grateful for the opportunity to participate in this initiative, which supports the development of land stewardship practices by combining Western data collection methodologies with Indigenous Traditional Knowledge. The exploratory design of the NAI dashboard has enabled us to visualize the complexity and interconnectedness of our local waterways in a meaningful and actionable way.

By mapping various land types and features, we are better equipped to allocate resources and prioritize restoration efforts in areas identified as ecologically or culturally critical. This approach ensures the protection and sustainability of our natural resources for future generations. We firmly believe that "knowledge

is power", and access to this knowledge enhances our ability to make informed, proactive decisions regarding flood mitigation, forest fire prevention, and other key functions such as referrals, consultations, and other preventative protocols within the Lands and Natural Resources departments.

The dashboard provides a visual interface that helps us connect natural resource locations with historical events and traditional practices. This not only supports responsible resource management but also promotes education and prevents over-harvesting. Metrics in the "cumulative effects" tab—such as watershed disturbance, clearcutting, and road density— allow us to assess the environmental impacts of development and climate change, enabling us to map these changes over time and focus future restoration efforts where they are needed most.

The vitality tab further highlights the resilience of our ecosystems and underscores the vital role that rivers play in the lives of Leq'á:mel people. Eulachon, salmon, and sturgeon, and other fish species are not only crucial for sustenance but are deeply embedded in our culture and traditions. As members of the broader Stó:lō Nation, often referred to as "people of the river", we recognize that water is foundational to our identity and way of life. The word "Stó:lō" in Halq'eméylem means "river", a testament to the central role waterways play in our history, culture, and spiritual practices. Understanding local hydrology is essential for mitigating the impacts of climate change and sustaining these vital ecosystems.

"S'ólh téméxw te íkw'elò. Xyólhmet te mekw' stám ít kwelát"
"This is our land. We have to take care of everything that belongs to us."

Looking ahead to future phases of the project, Leq'á:mel First Nation aspires to further incorporate Indigenous perspectives and cultural identity into the dashboard. This includes identifying places of cultural significance using traditional Halq'eméylem language, sharing historical photos and oral teachings, and integrating stories from Elders and traditional practitioners to promote intergenerational education and Indigenous-led land stewardship. Additional data—such as the locations of salmon, eulachon, and sturgeon spawning grounds, as well as more detailed forest inventory layers—would greatly enhance our capacity for informed stewardship.

This project has also sparked new ideas for community-based initiatives focused on conservation and education. For example, the development of a complementary mobile tool could allow community members to map culturally significant species and places, linking traditional knowledge with real-time data. Such tools would help foster a continuous feedback loop between the community and the Leq'á:mel Lands and Natural Resources staff.

We are deeply appreciative of this opportunity and the tools it has provided. It represents a significant step forward in strengthening our land stewardship efforts and supporting the ongoing growth and capacity of our Lands and Natural Resources Department.

REFINEMENT OF CONCEPT

NAI and LFN have refined the original concept of overlapping space between Traditional Ecological Knowledge and Western science, as presented at the beginning of the Project. (Figure 10). Specifically, as it relates to the development of the vitality measures. In addition, the concept that valuation and risk both require a more complex systems thinking to fully understand and map the data.

Figure 10: *Diagram Showing Potential Areas of Overlapping Attributes of Traditional Ecological Knowledge and Western Science (NAI & Neale 2024).*

REFERRALS

As noted in Section 4, a Project driver was the need for an efficient referral process. The idea was that if there was an efficient way of pulling all the publicly available data into interactive maps and provide a way for LFN to add their own information and respond based on that data, then the permitting process could be better managed in line with LFN priorities. A learning from the Project is that having this information in one dashboard allows the Guardians to plan where they will focus their ground-truthing efforts, as it is known that government data is not always accurate. It also allows for LFN to not rely solely on information provided by project proponents and government, and instead 'have a seat at the table' with their own data and, an LFN analysis of all available data, which relies on traditional knowledge, as well as scientific data collected by LFN to provide clarity on cumulative effects.

GUIDING QUESTIONS

Furthermore, a series of questions emerged to shape the common area between the two worldviews. These were discussed by all Project Partners and could be useful to consider in the context of future projects.

- **Ethics:** What are our values – how do we work together from the heart?
- **Relationality:** What are the stories that we have heard and know from the land?
- **Practice:** How are we approaching the work, what can we observe and verify — what are our ways of knowing?
- **Knowledge:** How do we share what we know? How do we hear each other's stories?

This project and LFN's efforts mark a key step in leveraging natural asset management for Indigenous land stewardship. Figure 11 is a screenshot from a short video release by LFN to share details of the inventory project and their ongoing work to recognize and quantify the natural resources and places of cultural significance within LFN territory.[10]

Figure 11: *Screenshot from Video 'Leq'á:mel First Nation Two Eyed Seeing Natural Asset Inventory' (2025)*

10 Watch the full video on YouTube www.youtube.com/watch?v=yXvGTUSJqFk

7.0 Conclusion and Next Steps

This project has been guided by an Etuaptmumk / Two-Eyed Seeing approach, with the goal of recognizing that managing natural assets in an Indigenous context requires a systems-based perspective. This means understanding the interconnectedness of all systems — any change to one part of the system (like using, altering, or restoring a natural resource) affects the rest of the system.

Through this work, the Partners have gained a deeper understanding of how Etuaptmumk / Two-Eyed Seeing supports Indigenous values and responsibilities, especially the duty to care for the land for future generations. It reflects the idea shared by Robin Wall Kimmerer (2013): that reciprocity is not just about gratitude, but about actively giving back and tending to the land as part of a moral responsibility.

This idea came through clearly in both the focus group and community meetings held with LFN. Participants expressed how much they valued the inventory dashboard. One audience member shared that they remembered a favourite food once harvested in a certain area and wondered if the dashboard could help explain what changed — and how to bring those conditions back. Another participant asked if the dashboard could be accessible on a phone, so they could compare real-time observations on the land with the mapped information, allowing them to act as citizen guardians of their territory.

The summary of this report was presented to the community at the end of Phase 1, and the even demonstrated how meaningful this tool is to the LFN community. Audience members immediately saw the value of interactive maps and how the information could support their connection to the land. Some of their feedback is included in Table 5 and Appendix C. A list of next steps, actions, timelines, and rationale have been provided in Table 5 below to create a framework for continuing this meaningful work.

Table 5: *Next Steps and Associated Timelines to Advance the Project*

Next Step	Actions	Rationale
Knowledge and Western data repatriation process	■ Provide all spatial and other data to LFN's GIS technician to be integrated into LFN's referrals and other systems as needed. ■ Develop a strategy to maintain and update the inventory, including the use of an online GIS platform to access the individual data layers used to develop the inventory and metrics. This platform should be available to Leq'á:mel citizens and LFN staff via a mobile and desktop app.	To ensure that LFN have control and access to this data as part of their data management systems in a way that adheres to the principles of OCAP.
Ensure that LFN is integrating the dashboard into existing systems and using it for planning and decision making	■ Community feedback documentation and workshop outcomes. ■ Literature review and expert recommendations on valuation methodologies. ■ Economic valuations for priority services and cultural values. ■ Communication plans and presentations tailored to LFN's goals.	These are the Deliverables identified in REFBC grant application
Risk Identification process	■ Develop a methodological approach for community engagement (potential continued use of Two-eyed Seeing approach) ☐ As part of this, work with Leq'á:mel citizens to develop a clear process for identifying risk from a Leq'á:mel perspective.	To gather insights on community-identified risks and hazards, and to develop a culturally appropriate risk framework that supports and advances NAI's understanding of risk to Indigenous communities.
Integrate an Leq'á:mel-citizen informed third dimension of risk	■ Work to integrate the core Leq'á:mel concept of Shxwelí into risk identification and assessment. An understanding that all things are connected. ☐ As part of this, identify core Leq'á:mel values for assessing risk. Sturgeon, Salmon, Eulachon being pivotal in understanding what the risks are to Leq'á:mel citizens (i.e. if fish species are at risk of being impacted, the health and wellbeing of Leq'á:mel people is also at risk). ■ Re-evaluate risk register including beneficial natural disturbances (e.g., fire)	Recognizes that some natural risks support ecosystem health and shifts the focus to nuanced management that understands the holistic worldview of Leq'á:mel citizens.

Next Step	Actions	Rationale
Document LFN community knowledge of cumulative effects and cascading risks	■ Facilitate Elder, knowledge holder, and citizen workshops ■ Identify pathways from ecological risk to human health and wellbeing risk (the risks to Leq'á:mel citizens from environmental change)	Pathways help visualize how environmental risks ripple through community well-being and culture
Compile knowledge-holder insights into risk list	■ Review existing data from Reciprocity's work ☐ Develop a community-driven list of risks	Builds from existing community knowledge and avoids duplication of effort
Identify mitigation strategies for core areas of LFN territory, as well as core species, resources, and practices that are at greatest risk from environmental change.	■ Identify actions to reduce risk, who is responsible for risk reduction, and when mitigations should occur ☐ Integrate reciprocity as a guiding principle	Ensure that natural asset mitigations are aligned with Leq'á:mel's understanding of Shxwelí, where mitigations are not focussed on single places, practices, species or resource, but work to protect this set of values holistically
Apply Risk Identification Tool	■ Use tool to assess service, strategic, O&M, financial, and political risks ☐ A focus on the strategic risk to LFN and their core values including: Cultural continuity; Land-based knowledge transmission; Health and well-being; Self-determination and stewardship ■ Conduct high-level consequence/ probability analysis	Provides a structured method to identify and prioritize top risks in natural asset management
Begin ecosystem valuation process	■ Determine which ecosystem services to value ■ Choose suitable methods (monetary & non-monetary; LFN specific that speak to LFN worldviews) ■ Engage LFN community for input and validation	Supports decision-making, restoration planning, and long-term protection of ecosystem services that support Leq'á:mel citizen's ability to use the lands and waters.
Develop Indigenous valuation framework	■ Collaborate with Reciprocity Research and Green Analytics to develop this framework ■ Explore identified Indigenous values as a foundation for holistic ecosystem valuation	Builds a values-based system recognizing all natural elements as interconnected and essential (Shxwelí)

Next Step	Actions	Rationale
Develop Natural Asset Investment Plan	■ Include: ☐ Leq'á:mel vision and guiding principles ☐ inventory of natural assets that includes LFN place names and otherwise ☐ includes threats and impacts from a Western and LFN perspective ■ Establish shared roles for maintenance, monitoring, and restoration ■ Align with valuation insights and community-identified risk priorities	■ Enables coordinated stewardship and invites funding/support from public/private sectors. ■ Identifies priority areas for investment based on LFN and Western knowledge systems (ie. wetland protection, riverbank protection, workshops on cultural burning and other Indigenous techniques for ecosystem management)
Plan for regenerative asset management	■ Explore long-term watershed scale LFN strategies priority strategies including but not limited to: ☐ Hydrological function of the streams, wetlands, floodplains and other natural features within LFN core territory (around Nicomen Island) ☐ Ecosystem connectivity (both hydrological connectivity and corridors for wildlife etc.) ☐ Rewilding clearcut and other areas that currently have hydrophobic and sedimentation effects on watercourses and slough areas ■ Center around resilience, restoration, and Indigenous-led governance and the concept of Shxwelí	Advances LFN's vision for their territory and ensures the ongoing health of ecosystems and community wellbeing (including the places, practices, species, and resources that are central to Leq'á:mel identity and enable Leq'á:mel citizens to be whole and healthy).

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Appendix A: Summary of Spatial Data Used

Table 6: *Summary of Available Open-Source Data Used for Project*

Input Dataset	Source	Description
Assessment Watershed Boundaries	Province of BC	Boundaries of assessment watersheds used to subdivide areas.
Watershed Groups	Province of BC	Broad level boundaries of watershed groups.
Fundamental Watersheds	Province of BC	Finer resolution scale of watersheds considered for summary statistics.
Aquifers	Province of BC	Polygons of groundwater aquifers used to summarize assets by which aquifers are in them.
BC Road Atlas	Province of BC	Linear vector feature of roads.
Building Footprints	Microsoft	Polygons of building footprints in Canada. Intended to remove buildings from areas of natural cover.
Annual Crop Inventory (ACI)	Government of Canada	30 x 30 m raster of land cover across Canada tailored to crop delineation. Informs general land cover and agricultural areas by specific crop type, where applicable.
Sentinel-2 Land Cover 2023	Impact Observatory	10 x 10 m raster of land cover types of the area in 2023. Used to confirm location of urban and built-up areas to remove from the inventory.
Sensitive Ecosystem Inventory (SEI)	Metro Vancouver	Polygon dataset of detailed natural land cover around Vancouver.
Freshwater Atlas (FWA) Wetland Polygons	Province of BC	Polygon dataset of wetlands in BC, used to help identify and delineate wetlands.
Freshwater Atlas (FWA) River Polygons	Province of BC	Polygons of river boundaries used to account for fluvial features in study area.
Freshwater Atlas (FWA) Lake Polygons	Province of BC	Polygon dataset of lakes in BC, used to help identify and delineate lake features.
Freshwater Atlas (FWA) Stream Lines	Province of BC	Line dataset of stream locations in BC. Us
Vegetation Resource Inventory (VRI)	Province of BC	Polygon dataset of vegetated areas in BC. Informs general land cover types.
POI and Traffic	Open Street Map (OSM)	Polygon datasets of points of interest and traffic features such as parking used to help identify natural areas.
First Nations Reserve Land Boundaries	Province of BC	Identifies First Nation reserve areas boundaries.
BC Cutblock Dataset	Province of BC	Polygons indicating locations of forestry harvesting in BC.
Pest Infestation Areas	Province of BC	Polygons of major pest infestations across BC. Used as supplementary Data.

Input Dataset	Source	Description
BC Crown Lands	Province of BC	Polygons of crown land activity, including oil and gas.
Pipeline Right of Ways /Segments (Permitted/Approved)	BC Energy Regulator	Polygons and lines of right of ways for major pipelines running through study area. Can be used to reclassify areas or as splitting criteria.
Sump Locations/ Pipeline Facilities	BC Energy Regulator	Point locations of pumps and pipeline facilities in study area.
BC Transmission Lines	Province of BC	Lines of major transmission lines in BC.
Critical Habitat for Canadian Species at Risk	Government of Canada	Polygons of critical habitat for federal species at risk across Canada.
Non-Sensitive Species Occurrence Data	Province of BC	Polygon data of occurrence of various non-sensitive species in the province.
Aquatic Invasive Species Point Locations	Province of BC	Points of known occurrences of aquatic invasive species.
BC Groundwater Well Data	Province of BC	Points of groundwater well locations in BC.
Forest Fires	Province of BC	Active/historic polygon data from the Province of BC.
Forest Fires	NASA	Visible Infrared Imaging Radiometer Suite (VIIRS VNP14IMGT).

Appendix B: Cumulative Impacts Metrics

Drawing on the B.C. *Cumulative Effects Framework*, several possible metrics from an asset management perspective were considered for application to Leq'á:mel. These are summarized below. Each metric was measured for each assessment watershed and/or fundamental watershed unit. The metrics are:

1/ Watercourse crossings
2/ Road density
3/ Linear disturbances
4/ Equivalent clearcut area[11]
5/ Old growth forest
6/ Percent of watershed considered intact.

Density of Watercourse Crossings

INDICATOR: Density of watercourse crossing (crossings per km²) within a watershed management unit.

RATIONALE: The density of water crossings within a watershed can be a useful measure of watershed condition as it provides insight into human impacts on the watershed's hydrology, ecology, and overall health. For instance, water crossings such as roads, bridges, and culverts, can disrupt the natural flow of water within a watershed. A higher density of crossings can indicate increased alteration of stream networks, potentially leading to changes in stream hydrology. This can affect the timing and magnitude of water flow, contributing to increased erosion, sedimentation, and flooding downstream. Healthy watersheds rely on the connectivity of their ecosystems and water crossings can fragment aquatic habitats by creating barriers that hinder the movement of aquatic organisms, such as fish and amphibians. Culverts and other crossings that are improperly designed or maintained may block species migration and reduce genetic diversity. Roads and crossings can contribute to sediment runoff and introduce pollutants into waterways, including oils, heavy metals, and road salts. By analyzing the density of water crossings, areas can be prioritized for restoration. For instance, areas with high crossing densities but significant ecological value may be targeted for rehabilitation projects, such as improving or replacing problematic culverts, reestablishing natural flow regimes, or restoring connectivity for aquatic species.

APPROACH: Density of watercourse crossings (crossings per km²) can be estimated by intersecting relevant linear features (e.g. roads and pipelines) housed in the geospatial database with the linear features representing the watercourses. Where possible, crossings could be identified by type (e.g. bridge, culvert, pipeline).

11 Equivalent clear-cut area factors in the area impacted by clear-cutting, area burnt by forest fires, and area impacted by pest outbreaks.

Density of crossings per unit area of the watershed could be measured as follows:

Crossing Density = count of crossings / watershed areas (km²)

RANKING: Proposed thresholds are based on scoring used by the BC Cumulative Effects Framework (British Columbia 2020a).

Table 7: *Proposed Impact Ranking Thresholds for Watercourse Crossings*

Impact Ranking	Threshold Criteria
Low	Crossing density < 0.24 crossings/km²
Moderate	Crossing density between 0.24 and 0.6 crossings/km²
High	Crossing density > 0.6 crossings/km²

Road Density

INDICATOR: Road density (km/km²) within each watershed management unit.

RATIONALE: Road density is a useful metric for assessing watershed condition since roads have significant environmental impacts and provide an indication of human disturbance on a watershed. Roads, especially unpaved ones, increase soil erosion, which can degrade water quality, harm aquatic habitats, and fill in stream beds. Roads can alter the natural flow of water in a watershed changing drainage patterns, increasing runoff, and reducing groundwater recharge. High road density can fragment natural habitats, limit or modify wildlife movement behaviour and increase the likelihood of wildlife-vehicle collisions. Higher road density often correlates with more intensive land use, which can lead to further degradation of watershed health.

APPROACH: Road density by watershed management unit can be calculated by summing the length of all roads within the watershed and dividing by the watershed areas.

RANKING: The BC CEF provides a few scoring criteria options which vary depending on the context in which they are applied. For instance, separate criteria are used when applied as a water quality metric versus a metric for grizzly bears as noted below.

OPTION 1: Thresholds based on water quality metric applied to sensitive watershed as defined by BC CEF (British Columbia 2020a).

Table 8: *Proposed Impact Ranking Thresholds for Road Density Based on Water Quality Metric Applied to Sensitive Watersheds*

Impact Ranking	Threshold Criteria
Low	Road density < 0.6 km/km²
Moderate	Road density between 0.6 and 1.2 km/km²
High	Road density > 1.2 km/km²

OPTION 2: An alternative (or secondary) water quality metric used by the BC CEF that is aligned with Watershed Assessment Procedure (WAP) benchmarks and was applied to all non-sensitive watersheds (British Columbia 2020a).

Table 9*: Proposed Impact Ranking Thresholds for Road Density Based on water Quality Metrics Applied to Non-Sensitive Watersheds*

Impact Ranking	Threshold Criteria
Low	Road density < 1.5 km/km²
Moderate	Road density between 1.5 and 2.1 km/km²
High	Road density > 2.1 km/km²

For this indicator we used Option 1 as it was most relevant to the Leq'á:mel First Nation context.

Density of linear disturbances

INDICATOR: Density of linear disturbance (km/km²) within each watershed management unit.

RATIONALE: Linear disturbance is a general metric that can be used to determine the cumulative anthropogenic footprint on a landscape. Linear developments such as oil and gas pipelines, power lines, railway lines, roads, cutlines and trails create corridors that can influences wildlife species in different ways. For instance, by dividing natural habitats into smaller and isolated patches, linear disturbances might lead to habitat fragmentation, higher animal mortality from vehicle collisions, and impact predator-prey dynamics.

APPROACH: Linear disturbance density can be calculated by dividing the total length of the linear disturbance (km) by the total watershed area (km²).

RANKING: Based on the review of literature, a couple disturbance density thresholds were identified as summarized below. The two sources used similar thresholds, but the associated impact rankings varied.

OPTION 1: Threshold criteria of all linear Feature Density (km/km²) provided by Fiera Biological Consulting Ltd (2014)

Table 10*: Proposed Thresholds for Linear Distrubance Density - Fiera Consulting*

Impact Ranking	Threshold Criteria
Negligible	All linear feature density < 0.6 km/km²
Low	All linear feature density between 0.6 to 1.2 km/km²
Moderate	All linear feature density between 1.2 to 3 km/km²
High	All linear feature density >3 km/km²

OPTION 2: Threshold values for linear disturbances effects on boreal caribou provided by Stantec (2011)

Table 11: *Proposed Thresholds for Linear Disturbance Density Provided by Stantec*

Impact Ranking	Threshold Criteria
Low	Linear Feature Density <0.6 km/km²
Moderate	Linear Feature Density between 0.6 to 1.2 km/km²
High	Linear Feature Density >1.2 km/km²

For this indicator we used Option 2 since it aligned well with three classification impact ranking.

Equivalent Clearcut Area (ECA)

INDICATOR: Equivalent clearcut area (precent of area) within a fundamental watershed management unit.

RATIONALE: Watersheds are highly sensitive to disturbances such as clear-cutting, logging and pest outbreaks. Ecological and hydrological impacts can increase non-linearly with the amount of land disturbed. To assess the impact and the risk of forest disturbance, the concept of Equivalent Clearcut Area, or ECA, is a commonly used indicator. ECA is defined as the "area that has been clearcut, with a reduction factor to account for the hydrological recovery due to forest regeneration and subsequent growth" (BC Forest Practice Board n.d). According to Zhang and Wei (2012), ECA measures can be used to represent the forest disturbance, factoring in hydrological recovery after different types of disturbance (such as wildlife, logging and Mountain Pine Bettle infestations), accumulated across both space and time within the watershed. By measuring disturbances across time and space, ECA provides a powerful indication of how cumulative land disturbances impact water, land, and overall ecological health. It also helps guide decision on the rate of harvesting and informs forest stewardship plans (Davidson et al. 2018)

APPROACH: ECA% can be measured by first calculating the ECA and then dividing the ECA by the area of disturbance. Davidson et al. (2018) used the ECA metric to assess BC aquatic ecosystem cumulative effects, and calculated ECA using the following equation:

ECA =Area * (1 – Hydrological Recovery Rate)

For example, an area of 100 ha that was disturbed 66 years ago would be assigned a 90% hydrological recovery. ECA in this case would be equal to 10 ha, calculated as 100*(1-0.9) = 10 ha. The following table, adapted from Davidson et al. (2018), provides an easy reference of hydrological recovery rate based on the year since disturbance. It indicates that, as more time passes after a forest disturbance, hydrological recovery improves reflecting greater forest regeneration and growth, and results in a lower ECA estimate.

Table 12: *Percentage of Equivalent Clearcut Area (ECA) Hydrological Recovery Over Time*

Time since disturbance	ECA Hydrologic Recovery
24	0%
39	25%
48	50%
60	75%
66	90%

After the ECA is calculated, the ECA% can be calculated by dividing the ECA values by the area of disturbance, to yield the ECA%.

RANKING: The following criteria, adapted from Davidson et al. (2018), can be used to assign a ranking to the land disturbance within a fundamental watershed.

Table 13: *Proposed Impact Ranking Thresholds for Equivalent Clearcut Areas*

Impact Ranking	Threshold Criteria
Low	ECA% < 25%
Moderate	ECA% between 25 – 45%
High	ECA% >45%

Old Growth Forest Percentage

INDICATOR: Percent of current old growth forest under historic disturbance regimes within a fundamental watershed management unit.

RATIONALE: Old growth forests support high levels of biodiversity. Their complex structures also create unique habitats for numerous species such as a wide range of birds, mammals, insects, fungi and understory plant communities. They also play a critical role in maintaining ecosystem resilience. Old growth forests are crucial to climate regulation, serving as a major carbon sink. They also support water regulation by stabilizing soils, slowing down runoff and maintaining hydrological cycles. All those critical functions of old growth forest make it a common proxy for measuring ecological condition.

APPROACH: Price et al. (2021) provided a detailed framework for calculating the old growth forest percent for British Columbia. It can be measured by first determining current old growth forest area based on what qualifies as old forest, which varies by the biogeoclimatic zones: 250 years for wet zones (e.g., Coastal Douglas-Fir), 120 years for drier zones (e.g., Montane Spruce), and 120 years for the Boreal White and Black Spruce (BWBS) zone[12]. The area of expected

12 Detailed forest age thresholds for categorizing as old forest for each biogeoclimatic zones are available in Prince et al., 2018.

old growth[13] is then estimated using provincial government disturbance return intervals based on a negative exponential disturbance model. Finally, the current old growth in each biogeoclimatic zone is compared to the expected values under historic disturbance regimes to assess ecological risk.

RANKING: Comparing current old growth with expected old growth, condition ranks can be assigned as per the following table.

Table 14*: Proposed Impact Ranking Thresholds for Old Growth Forests*

Impact Ranking	Threshold Criteria
Low	>57% of historic disturbance
Moderate	44% - 57% of historic disturbance
High	<43% of historic disturbance

Percent of Watershed Considered Intact

INDICATOR: Percent of a fundamental watershed that is considered "intact."

RATIONALE: This indicator draws on the provincial human disturbance data set which captures all known human disturbances on the land base.[14] The data captures a range of disturbances such as cut blocks within the last 20 year, geophysical seismic lines, anything the province indicates is human or built up areas, transmission lines, pipelines, oil and gas wells, well site, road and rail infrastructure.

For this indicator, the intention is to include a measure that aligns with the precedent set by the June 2021 Supreme Court of British Columbia ruling that the Province of BC had unjustifiably infringed on the Treaty Rights of the Blueberry First Nation. That decision was influenced by the fact that as of 2018, 85% of Blueberry's territory was within 250 m of industrial disturbance and that 91% was within 500 m of a disturbance. The Court concluded the province had taken up lands so extensively that Blueberry First Nation could not meaningfully exercise their treaty rights (Hamilton and Ettinger 2023).

While the condition and treaty rights of the Blueberry First Nation is much different to Leq'á:mel First Nation, this indicator still helps demonstrate the extent to which traditional uses of the territory have been impacted.

APPROACH: The 2023 Human Disturbance layer of the BC Cumulative Effects Framework was utilized to determine areas of human disturbance. All human disturbances are buffered by distances of 500m. Discrimination between types of disturbances was not undertaken for this exercise because the primary focus of this exercise was to identify intact lands. Intact lands are defined as any are of land that is outside the 500m buffer of a human disturbance. The area of

13 Expected value for each of the biogeoclimatic zones is available in Prince et al., 2018.

14 *catalogue.data.gov.bc.ca/dataset/7d61ff12-b85f-4aeb-ac8b-7b10e84b046c*

fundamental watersheds was then compared with the areas of the disturbance buffer. To determine the area of intact land, the area disturbed was subtracted from the total area of the fundamental watershed within the buffer distance, which was then converted into a percentage value to determine the condition rating threshold of each fundamental watershed.

RANKING: There were no clearly articulated thresholds that could be relied upon to support a ranking approach for this indicator. However, drawing on the Blueberry First Nation precedent as a reference point it seemed reasonable to assume area that is less than 35% intact (or 65% of area disturbed) would significantly limit a Nations ability to exercise their traditional land uses.

Table 15*: Proposed Thresholds for Intact Watersheds*

Impact Ranking	Condition Ranking	Threshold Criteria
Low	Good	> 45% of area considered intact
Moderate	Moderate	> 35-45% of area considered intact
High	Poor	< 35% of area considered intact

Appendix C: Leq'á:mel First Nation Community Meeting March 13, 2025

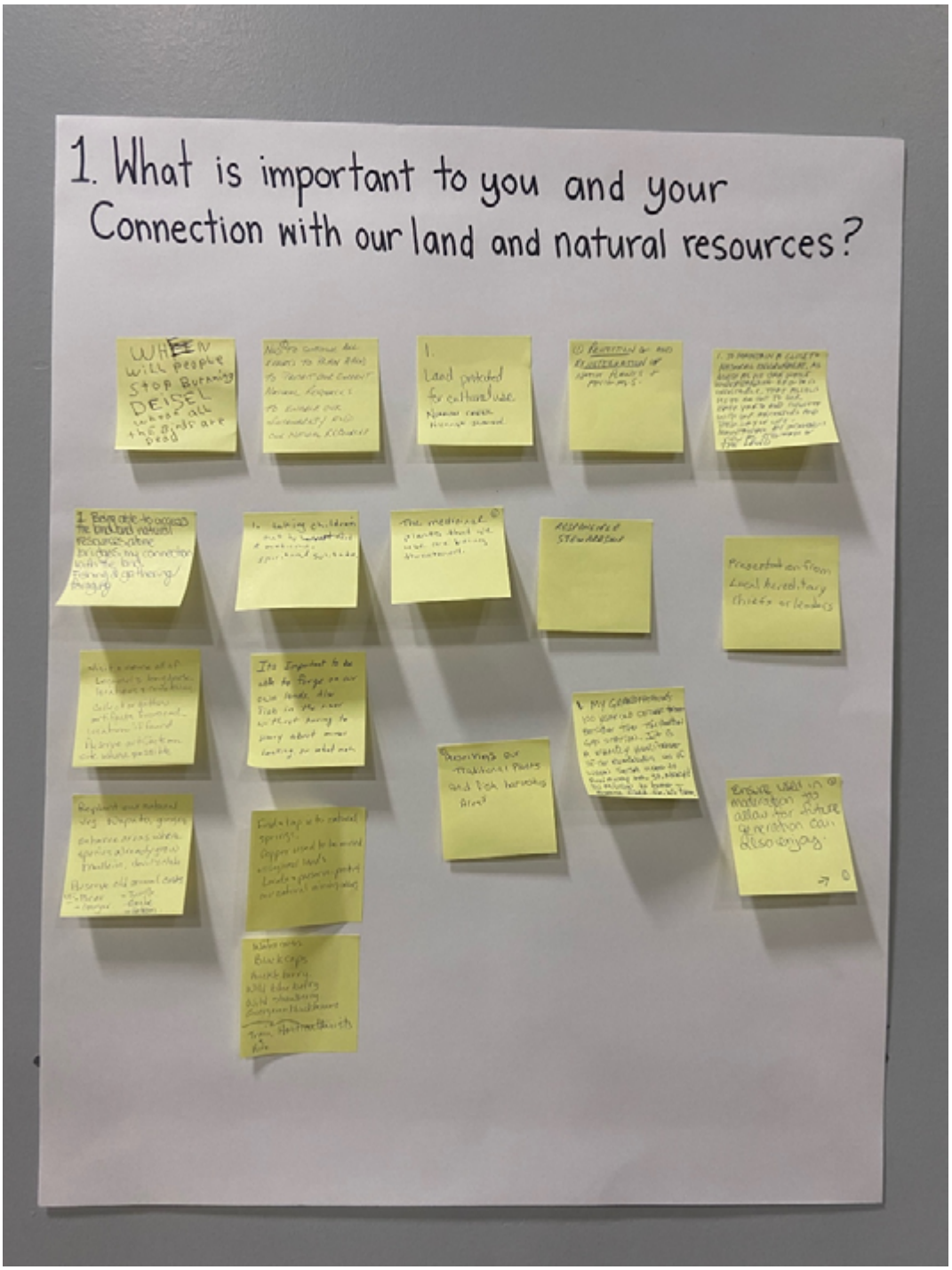

Figure 12: *Important Connections to the Land - Responses from Leq'á:mel First Nation Community Meeting*

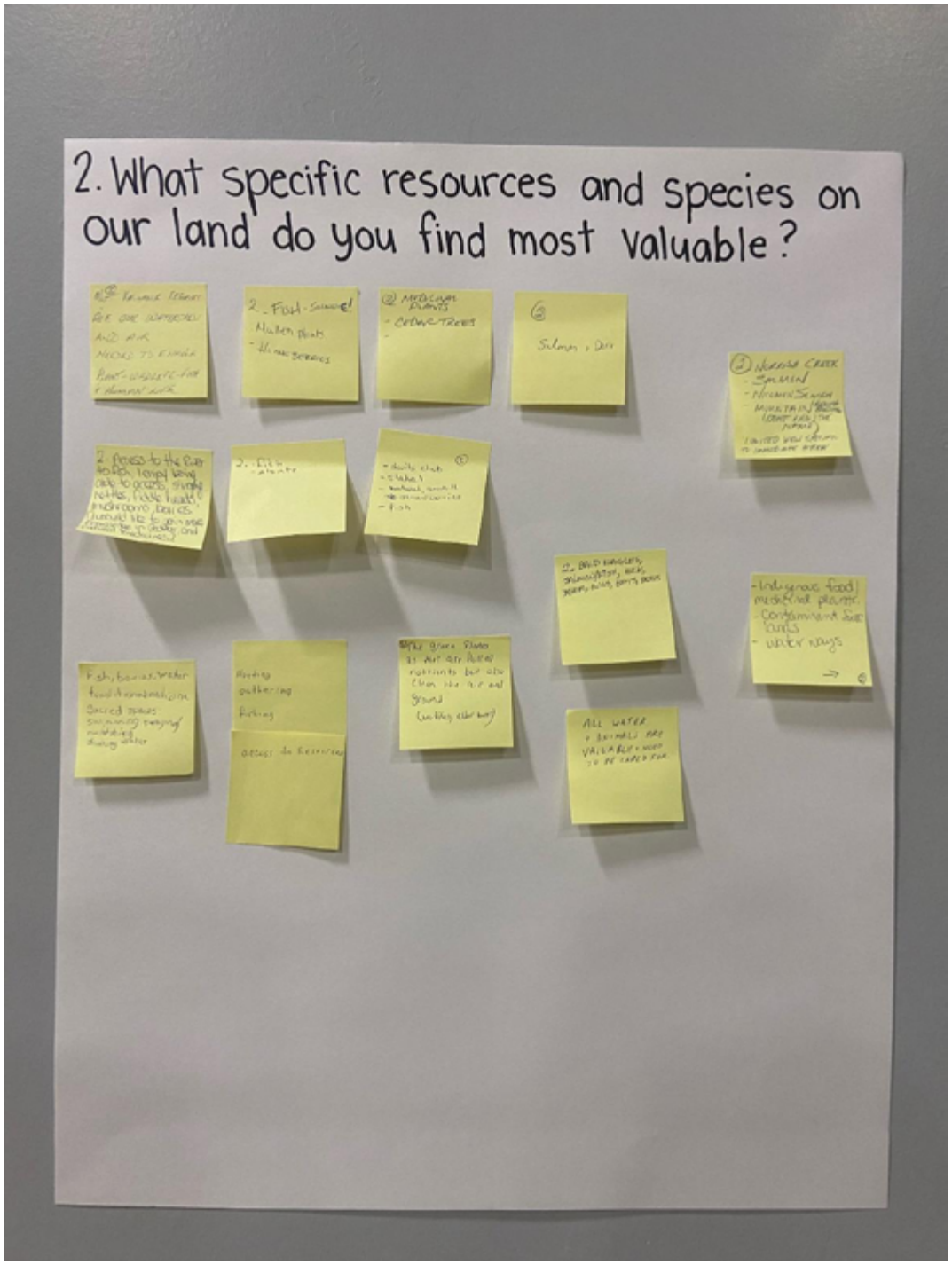

Figure 13*: Valuable Resources and Species - Responses from Leq'á:mel First Nation Community Meeting*

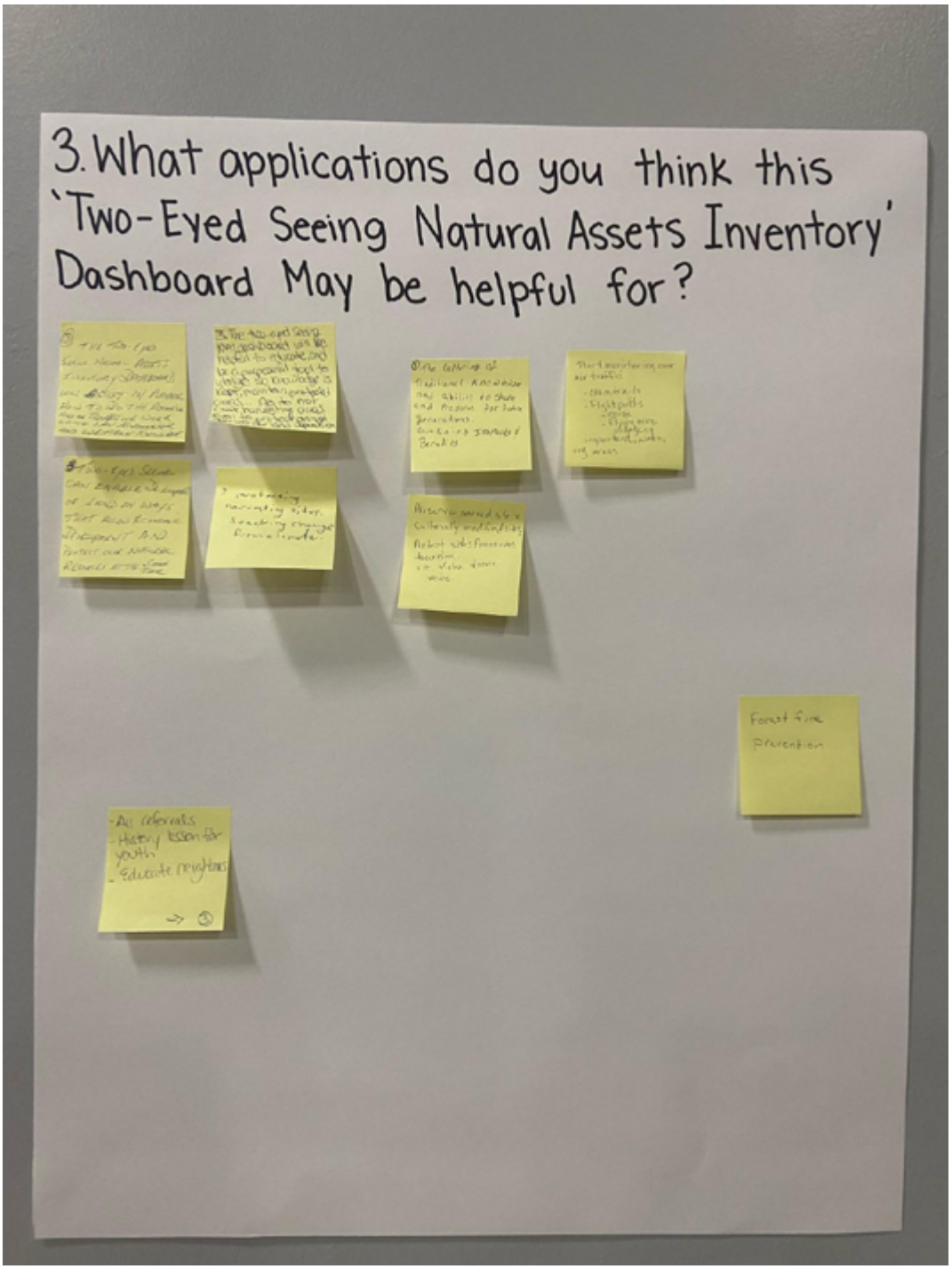

Figure 14: *Applications for 2ES Inventory - Responses from Leq'á:mel First Nation Community Meeting*

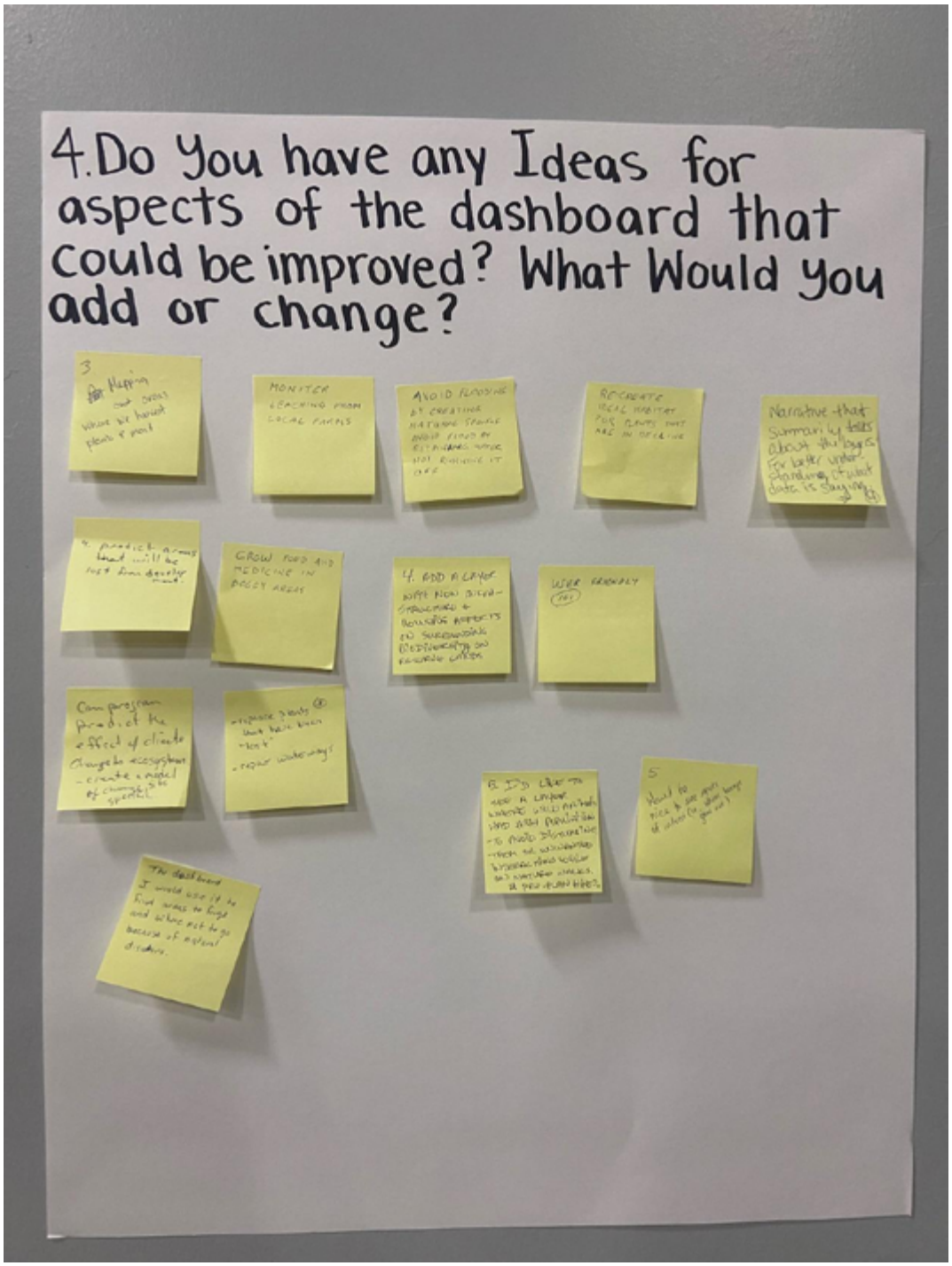

Figure 15*: Dashboard Improvements - Responses from Leq'á:mel First Nation Community Meeting*

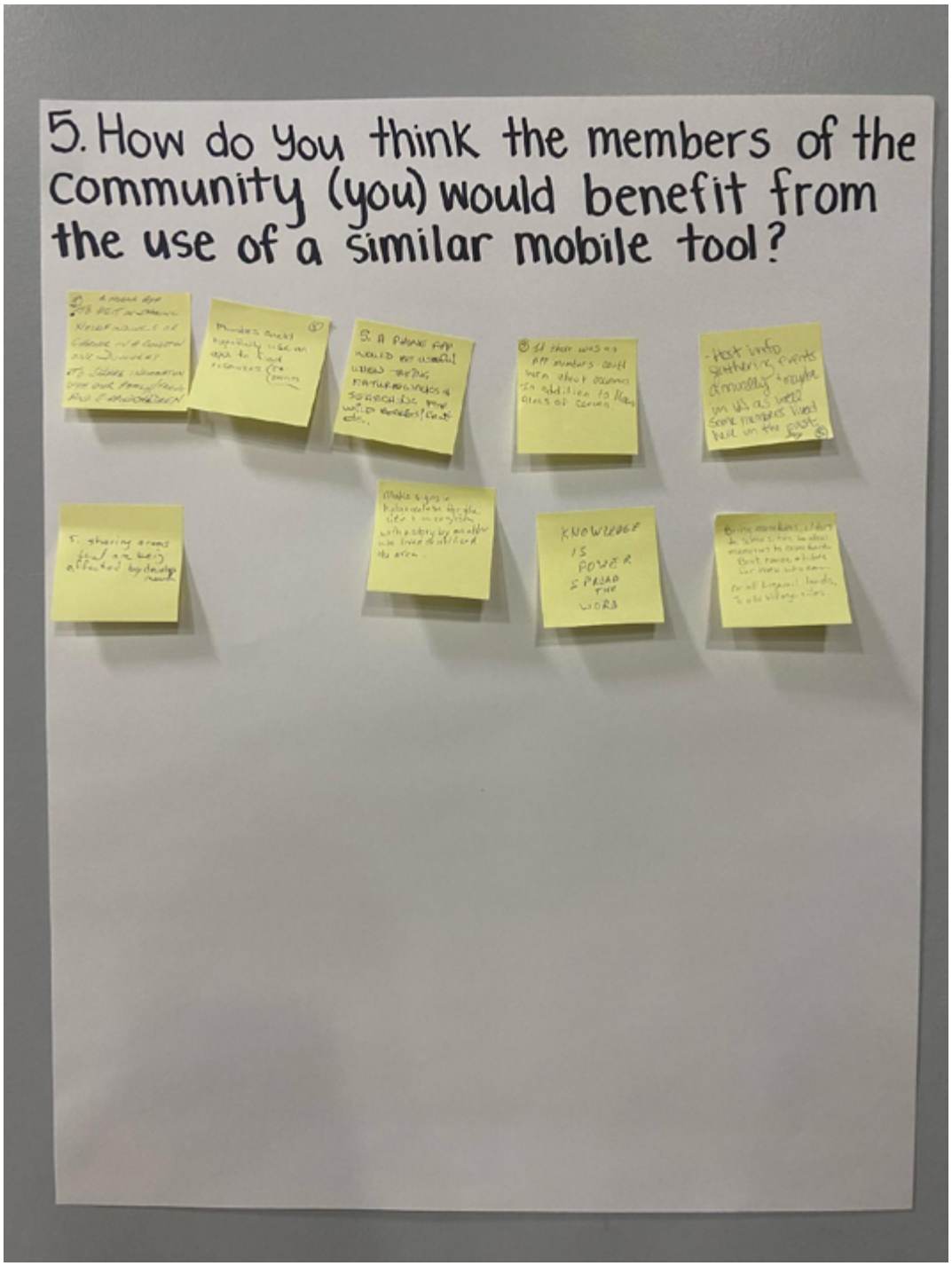

Figure 16: *Mobile Tool Uses - Responses from Leq'á:mel First Nation Community Meeting*

Natural Assets Initiative

MAKING NATURE COUNT

Website: *naturalassetsinitiative.ca*