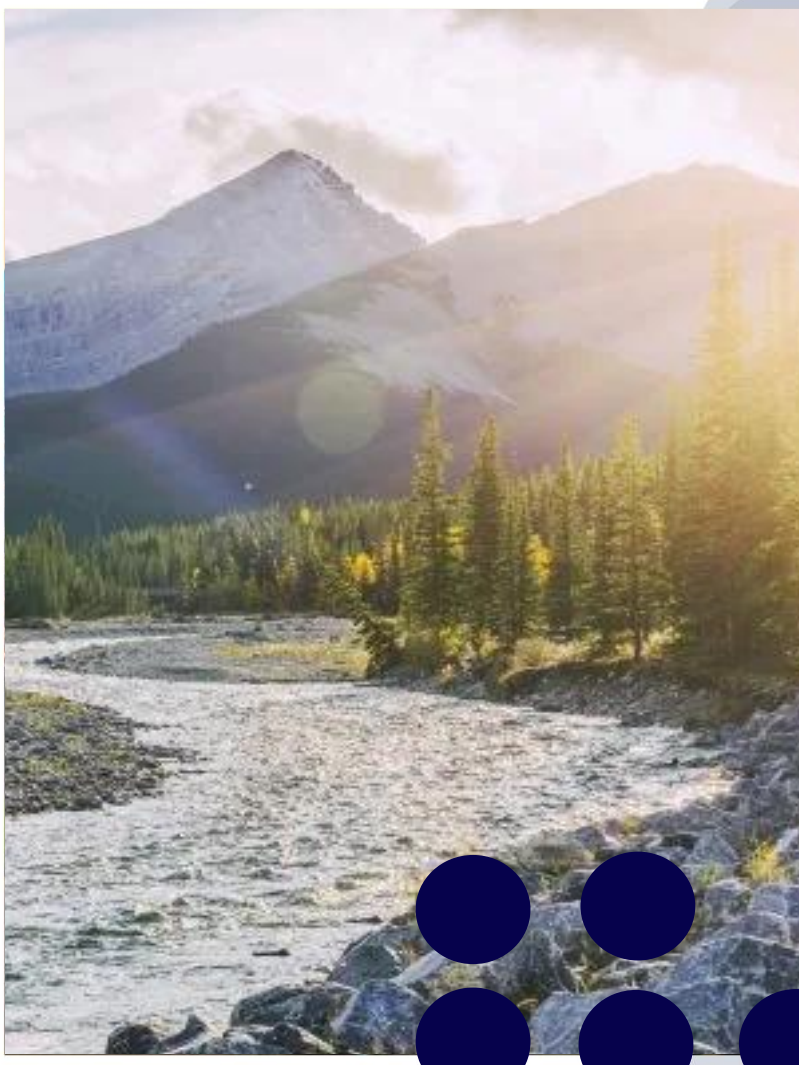


# Greater Bragg Creek
# State of Natural Assets Report

– September 2025

# Table of Contents

# 1 Introduction

Natural assets (e.g., wetlands, forests, grasslands, meadows, watercourses) provide numerous ecosystem services, including, for example, the provision of clean drinking water, improved air quality, carbon storage and sequestration and flood control. Natural asset management recognizes natural assets and the range of services they provide, and seeks to ensure they are effectively managed to avoid deterioration of the assets and associated services. The first step in natural asset management is creating a natural asset inventory. Such inventories quantify the type, location and extent of the natural assets within an area of interest. The services provided by those assets can then be identified, quantified and valued. Ecosystem service valuation supports the business case for conservation through land use planning. By quantifying the natural assets and the services the assets provide, growth that will inevitably mean some loss of natural habitat, can be balanced with the conservation of high value assets.

Rocky View County understands the role that natural asset inventories and ecosystem service valuation can play in informing land use strategies. The Area Structure Plan (ASP) Amendment Project will create a land use strategy for the Bragg Creek Hamlet Growth Area. The ASP must balance multiple priorities including economic development, recreational opportunities and infrastructure services, while also protecting and enhancing the natural environment. The ASP will need to demonstrate how this balance is being achieved. A natural asset inventory and ecosystem services valuation can inform the ASP Hamlet Review Project. Thus, the purpose of this project is to complete a natural asset inventory and ecosystem service valuation of the natural assets within the Bragg Creek Hamlet Growth Area.

The figure below depicts the approach employed in the current study. Through this project, a natural asset inventory that quantifies the location, extent and type of natural assets wthin the area of interest was undertaken. The condition of the assets was evaluated and replacement costs assigned. A risk assessment was conducted to identify and rate priority hazards and a valuation of ecosystem services provided by the assets was undertaken. The results of these tasks are summarized in the current report.


**Figure 1-1**. Approach overview.

To demonstrate the range of assets included in the Bragg Creek Hamlet Growth Area natural asset inventory, it is helpful to consider the scope of assets commonly managed by local governments. Figure 1-2 demonstrates the range of assets, including various types of green infrastructure (GI) (highlighted in the green boxes) and grey infrastructure (highlighted in the grey box), frequently managed by local governments. Relationships between terms commonly used to describe GI, such as nature-based solutions, nature-based climate solutions, and low-impact development, are also illustrated in the figure. Three sub-types of GI—natural assets, enhanced assets, and engineered assets—are distinguished, with examples provided for each. The asset inventory for the Bragg Creek Hamlet Growth Area, which focuses on natural and enhanced assets, is informed by this classification structure.

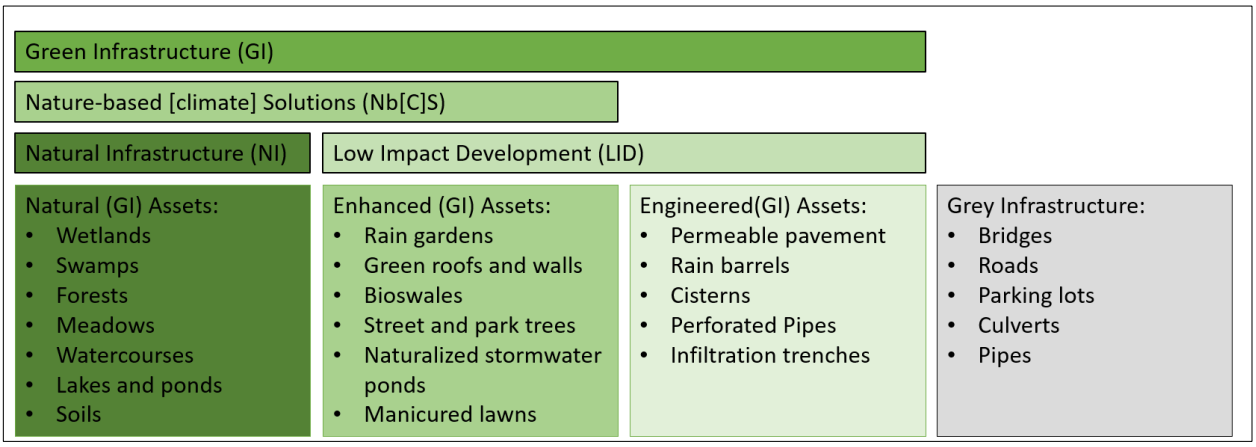



**Figure 1-2**. Defining natural and enhanced assets.

Bragg Creek, Alberta is situated in the Foothills Natural Region and characterized by montane ecosystems that serve as a transitional zone between prairie grasslands and subalpine forests. The region features a diverse topography including undulating morainal uplands, glacially carved valleys, and fluvial systems such as the Elbow River, which contributes to local hydrology and supports riparian habitats. Vegetation is dominated by lodgepole pine, white spruce, and trembling aspen. The region is characterized by an extensive network of multi-use trails, including the West Bragg Creek Trail System, which provides opportunities for hiking, mountain biking, cross-country skiing, and horseback riding. Notable natural attractions include the Canyon Creek Ice Cave, also known as the Bragg Creek Ice Cave, and nearby peaks such as Moose Mountain and Jumpingpound Mountain. These natural areas provide important ecosystem services, such as supporting biodiversity, maintaining air and water quality, offering wildlife habitat, and contributing to climate regulation through carbon storage and temperature moderation. To ensure management of these areas and the continued provision of these services, it is prudent to inventory and assess the natural assets within Bragg Creek. Hence, the purpose of this work. This report presents Bragg Creek Hamlet Growth Area's natural asset inventory and desktop (GIS-based) condition assessment. It is organized as follows:

- A **Policy and Document Review** section describes the existing Rocky View County policies relevant to natural assets.
- The **Asset Inventory** section describes the approach employed to quantify Bragg Creek's assets along with the results of the inventory, which describes the type, location, extent and replacement cost of assets within the Bragg Creek Hamlet Growth Area's boundary.
- The **Condition Assessment** section describes the indicators used to assess the ecological condition of Bragg Creek's natural assets as well as the results of that assessment, which rates the natural assets on a scale from very poor to very good.

- The **Risk Assessment** section describes the risk profiling exercise undertaken as part of the natural asset inventory.
- The **Ecosystem Service Valuation** section presents the results of the ecosystem service valuation.
- The **Summary and Recommendations** summarizes the findings and identifies recommeded next steps for Bragg Creek and Rocky View County to advance natural assets in the context of the upcoming ASP.

# 2 Rocky View County Policy and Document Review

Rocky View County is in the process of updating its ASP for the Hamlet of Bragg Creek. As part of the current project, Associated Engineering Ltd. (Associated) completed a high-level review of local policies, plans, and studies that relate to community growth and natural assets. These documents and policies provide important context to ASP updates and the Bragg Creek Hamlet Growth Area's natural asset inventory.

An overarching theme from the review is that there is a need and interest in both developing the Hamlet as well as protecting natural areas. It can be difficult to achieve a balance between development and protecting natural areas as they are inherently at odds, yet the 2007 ASP demonstrates there is strong public support to achieve both goals.

> **ASP Vision (2007): "**…residents have a strong sense of place that emanates from both the quiet country residences that harmonize with undisturbed landscapes and the small-town character of the hamlet… [The Hamlet] evaluates opportunities for subdivision and development by first **considering the capability and capacity of the natural environment to accommodate additional development.**"

The ASP update is guided by similar themes including:

- **Community Identity** – Maintaining the local character and charm of Bragg Creek while planning for future growth.
- **Inclusive Community** – Supporting a diverse range of housing, services, and amenities to meet residents' needs.
- **Regenerative Development** – Exploring sustainable infrastructure that balances environmental stewardship with economic and residential expansion.
- **Sustainable Visitor Economy** – Recognizing Bragg Creek's appeal to tourists while mitigating potential impacts of overtourism.
- **Living with Limits** – Respecting the ecological and infrastructural limits of the community to ensure future growth matches the hamlet's capacity and protects its natural assets.

The Hamlet has identified several opportunities to help achieve this vision and strike a balance between development and natural area protection. However, it is unclear to what extent these opportunities have been implemented or how well they work. The ASP update, natural asset inventory and ecosystem service valuation, and additional projects create opportunities to continue and strengthen the work already completed to protect natural assets.

Another critical insight is that both the ASP (2007) and Wildfire Mitigation Strategy (2012)[1] identified that the **hamlet is at a very high risk of wildfire**. Wildfire mitigation (e.g., deadfall clearing) **is important to reduce the community's risk to wildfire, however, this can be in tension with the desire to leave natural areas undisturbed**. Environmental Reserves (ER) are a great example of this tension, because while they are an effective tool for protecting natural areas, they largely require that areas are left undisturbed.

Table 2-1 identifies how the reviewed documents align with Bragg Creek Hamlet Growth Area's natural asset

[1] An updated Wildfire Mitigation Strategy will be available in 2025.

inventory and ecosystem service valuation.

**Table 2-1** Summary of Alignment Between Existing Policies, Plans, or Studies and the Natural Asset Inventory.

| Policies, Plans, or Studies | Alignment with Natural Asset Inventory and Valuation |
|---|---|
| **Bragg Creek Area Structure Plan** | • Guiding document approved by Council and adopted by bylaw. An area structure plan outlines the vision for the future physical development of an area with regard to matters such as land use, transportation, protection of the natural environment, emergency services, and utility service requirements. |
| **Bragg Creek ASP Network Review Traffic Impact Assessment** | • Identifies necessary upgrades to existing roadways to support population growth.<br>• Recommends the construction of a single lane roundabout at the intersection of Highway 22 / White Avenue, a well-established transportation route. Given the size of the roundabout, the reduction in natural area should be minimal.<br>• Recommends gravel access roads (Burney Road and East Park Place) are transitioned to a paved roadway with various trade-offs. This would reduce the amount of permeable surface (although many gravel roads are highly compacted and have minimal permeability) and increase heat retention from the road. Paved roads reduce the amount of sediment runoff from the gravel roads. |
| **Wildfire Mitigation Strategy** | • Wildfire risk is extreme. There is a challenge with leaving ER in their natural state because deadfall clearing is an important FireSmart strategy.<br>• Describes recommendations (e.g., building design requirements, landscaping guidelines, ongoing maintenance) that the public and local government can do to reduce wildfire risk.<br>• An updated Mitigation Strategy will be released in 2025. |
| **Rocky View County Parks and Open Space Master Plan** | • Emphasis on maintaining open space for public access, wildlife corridors, and drainage. Water is the most important natural resource in the context of the plan.<br>• Recognizes that natural systems do not respect man made boundaries and the need to collaborate with adjacent communities (i.e., promotes connectivity).<br>• Identifies what matters to the public as it relates to valuing natural assets, how they want to interact with natural assets, and how they want to be involved in natural asset management.<br>• Proposes strategies for maintaining asset condition and protecting natural assets (e.g., Land Acquisition Strategy, developer cost-sharing for natural areas, etc.). |
| **Biophysical Attributes Rating in the M.D., of Rocky View No. 44** | • Identifies the Biophysical Attribute Rating Variables (aquifer vulnerability, landcover, roadless lands, parks and protected areas/environmental reserves, and riparian areas).<br>• Proposes science-based recommended setbacks along riparian areas to protect creeks, wetlands, lakes and other natural water bodies.<br>• Suggests management protocols to ensure ecological integrity of ER. |

# 3 Asset Inventory

This section provides an overview of the approach and outputs related to the Bragg Creek Hamlet Growth Area's asset inventory.

## 3.1 Inventory Approach

An asset inventory provides the foundation for all other asset management tasks. The approach to creating Bragg Creek Hamet Growth Area's inventory aligns with Canada-wide standards and specifications for natural asset inventories (CSA-2022). The inventory is created in GIS, amalgamating relevant data to compile a complete picture of the type, location, and extent of assets within the municipal boundary. For the purposes of this report, the term "assets" refers to the two asset classes contained within the inventory:

1. **Natural assets**, which are comprised of natural features including forests, open water and grasslands.
2. **Enhanced assets**, which are comprised of semi-natural features that are more manicured and actively maintained such as urban trees and manicured greenspaces.

Figure 3-1 categorizes natural and enhanced asset classes into a series of asset types that are relevant to the Bragg Creek context. Natural asset types include forests, grasslands, wetlands, open water, and sparsely vegetated areas. Enhanced asset types capture built-up pervious areas.

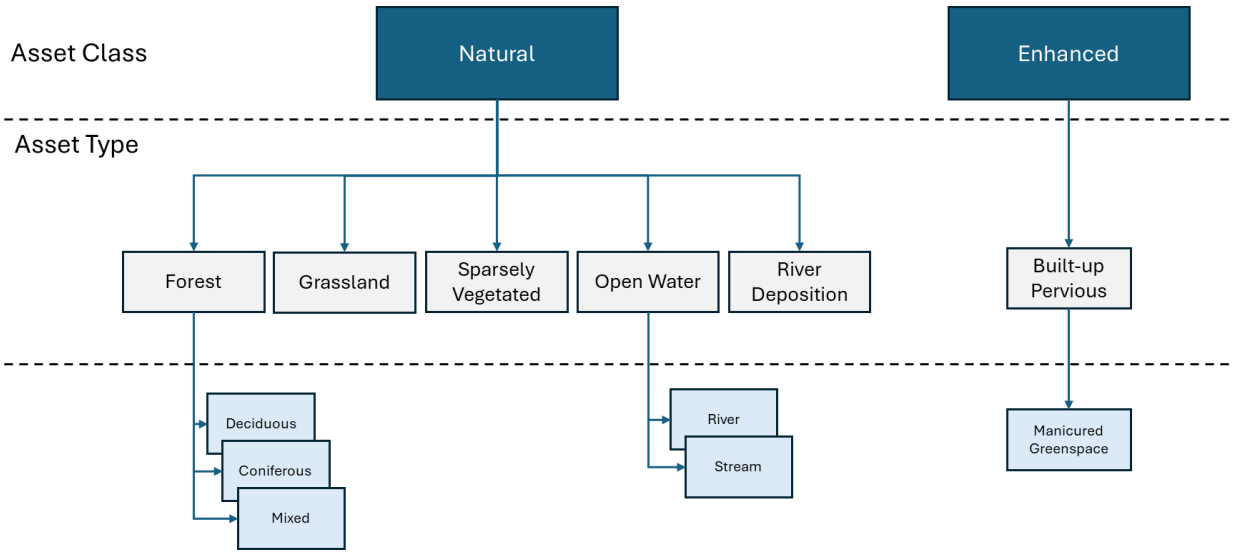



**Figure 3-1**. Bragg Creek Hamlet Growth Area asset inventory hierarchy.

While the asset inventory distinguishes between publicly and privately owned assets, this report presents inventory outputs for all natural assets within the Bragg Creek Hamlet Growth Area. Publicly owned natural assets do not function independent of nearby lands owned by others. As a result, the inventory and condition assessment include all natural asset types and classes within the study area.

Numerous spatial data layers were reviewed and incorporated into the inventory (see Appendix A for a complete list of spatial data used). Several data processing steps were undertaken to categorize assets into natural and enhanced asset classes as well as asset types. The remainder of this section provides additional details on the approach to identifying and categorizing Bragg Creeks' natural land cover into natural and enhanced asset types.

### 3.1.1 Delineating Assets

To develop the asset inventory, a range of input datasets were obtained and reviewed. Alberta's Land Use and Land Cover dataset was initially considered for its broad overview of the landscape in the study area. However, its resolution was insufficient for the precise delineation required for the inventory, making it unsuitable as a primary source for mapping natural assets.

The 2023 ESRI and Impact Observatory Sentinel-2 satellite classified land cover was also assessed for its appropriateness. Although this dataset provided useful contextual information about forested areas, it was found to significantly overestimate built environments. Many natural areas were inaccurately classified as developed land, which would have led to substantial gaps in the natural asset inventory. Nonetheless, its classification of forest types proved valuable for distinguishing specific forest categories, such as coniferous and mixed forests.

Due to limitations in the available datasets, all non-water natural features were delineated manually in GIS. This hands-on approach ensured greater accuracy and consistency in representing the natural landscape within the Bragg Creek Hamlet Growth Area. For waterbodies and watercourses, reliable spatial data was available. The Rocky View County hydrology dataset provided precise delineation of the Elbow River, while provincial surface water vectors contributed detailed information on the stream flowing into the river. Table 3-1 defines the asset types into which the assets were delineated.

**Table 3-1**. Definitions for natural and enhanced assets.

| Asset Class | Asset Types | Description |
|---|---|---|
| Natural | Forest | Any significant clustering of tall (~15 feet or higher) dense vegetation, typically with a closed or dense canopy |
| | Grassland | Ecological feature characterized predominantly by grasses, herbs, and occasionally sparse shrubs, with few or no trees. |
| | River Deposition | Ecological feature characterized by minimal or no vegetation cover, where the surface is predominantly exposed soil, rock, sand, or gravel and located within the fluvial areas of the river. |
| | Open Water | Waterbody characterized by the presence of standing or flowing water with minimal vegetation cover on its surface. |
| | Sparsely Vegetated | Ecological feature characterized by minimal plant cover, often found where environmental conditions such as poor soil quality or frequent natural disturbance limit the growth of vegetation. |
| Enhanced | Built-Up Pervious | Areas that have been modified or maintained through human activities but still allow for water infiltration into the ground. These lands are characterized by a managed or landscaped surface, often covered with grass, shrubs, or other vegetation, and are designed to support natural drainage |

Built features, including buildings, roads, and other non-natural land cover types, were systematically erased from the inventory dataset. This step was critical to isolate and highlight natural features, ensuring the dataset accurately represented the region's natural assets.

It should be noted that the flood spillway was not included in the asset inventory. While this feature could be considered an enhanced asset, it is already accounted for in existing Rocky View County asset management plans.

### 3.1.2 Inventory Attributes

Each asset within the inventory has a series of attributes associated with it. Attributes describe features or characteristics of the asset that may be relevant to the local government to inform management decisions. Attributes contained in the Bragg Creek Hamlet Growth Area inventory include:

- Unique asset ID
- Asset class
- Asset type
- Asset sub-type
- County classification of land
- Ownership
- Maintenance responsibility
- Intersects floodway
- Intersects flood fringe zone
- Basins and sub-basins
- Condition ratings

As part of Rocky View County's process of updating the ASP for Bragg Creek, an *environmental screening report and wildlife habitat modelling* was completed (RC BioSolutions Ltd. 2025). Several valuable and informative data sources were identified and developed as part of that research. Some of this information has been integrated into the natural asset inventory. More specifically, the inventory has been structured to include the following additional attributes from that work:

- Bull trout habitat – natural assets intersecting these habitat areas are noted
- Leopard frog habitat – natural assets intersecting these habitat areas are noted
- Key wildlife area – natural assets intersecting these habitat areas are noted
- Grizzly support zone – natural assets intersecting these habitat areas are noted
- FWMIS (observation points) – a count of observations within each asset.
- Wildlife habitat modelling results – average connectivity value within each asset

This data has been integrated into the asset inventory to help identify noted connections between the natural asset areas and some of the specific environmental data. When making land use decisions, the full suite of environmental data should be reviewed and assessed.

## 3.2 Summary of Inventory Outputs

The remainder of this section summarizes outputs derived from the Bragg Creek Hamlet Growth Area asset inventory. Figure 3-2 depicts the location and extent of natural and enhanced assets within the Bragg Creek

Hamlet Growth Area boundary. Figure 3-3 shows the same by asset type. This figure depicts the range of natural and enhanced asset types distributed across the landscape. Forest assets dominate the inventory area; other notable asset types include grassland, open water, and river deposition.

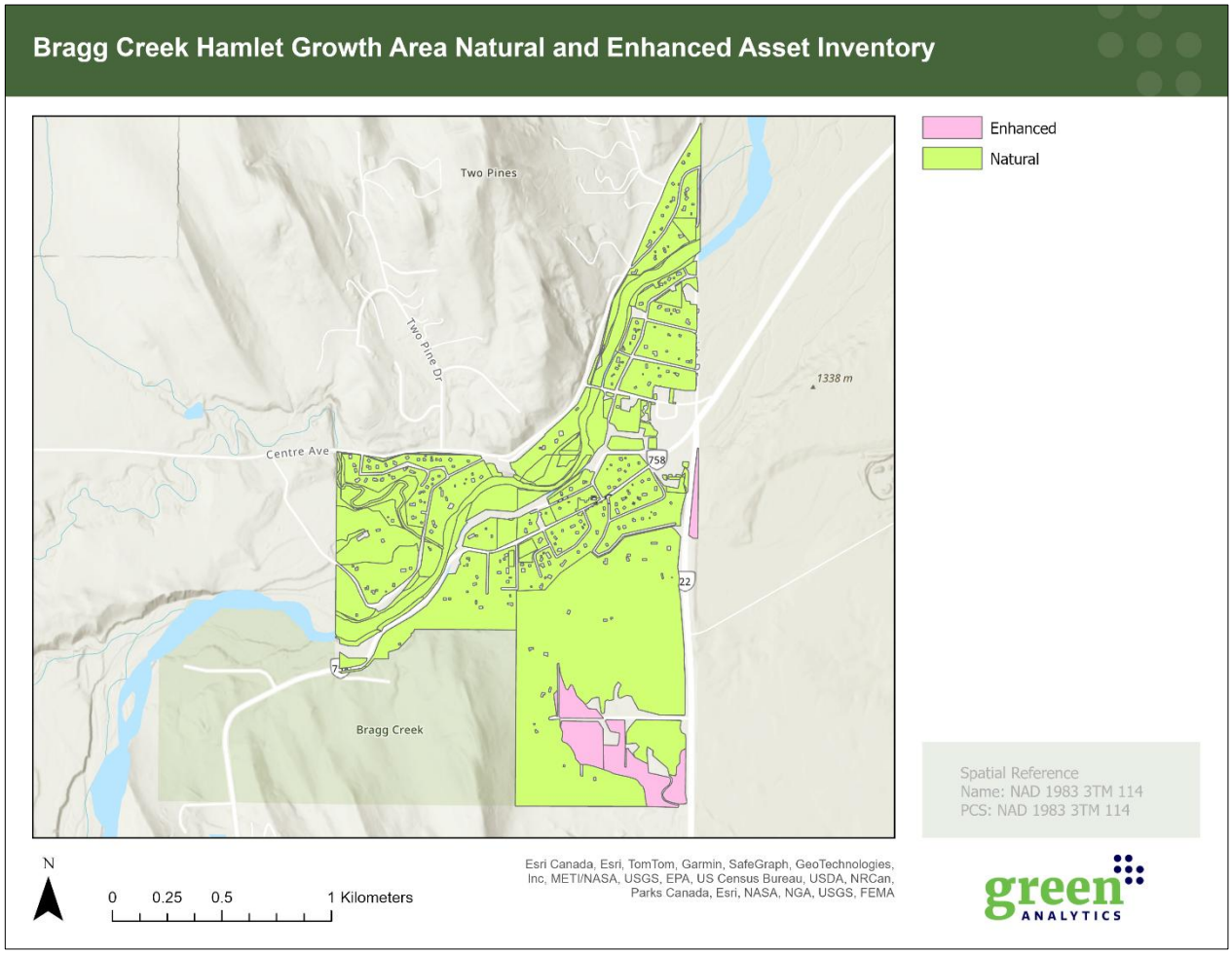



**Figure 3-2**. Natural and enhanced asset classes in Bragg Creek Hamlet Growth Area.

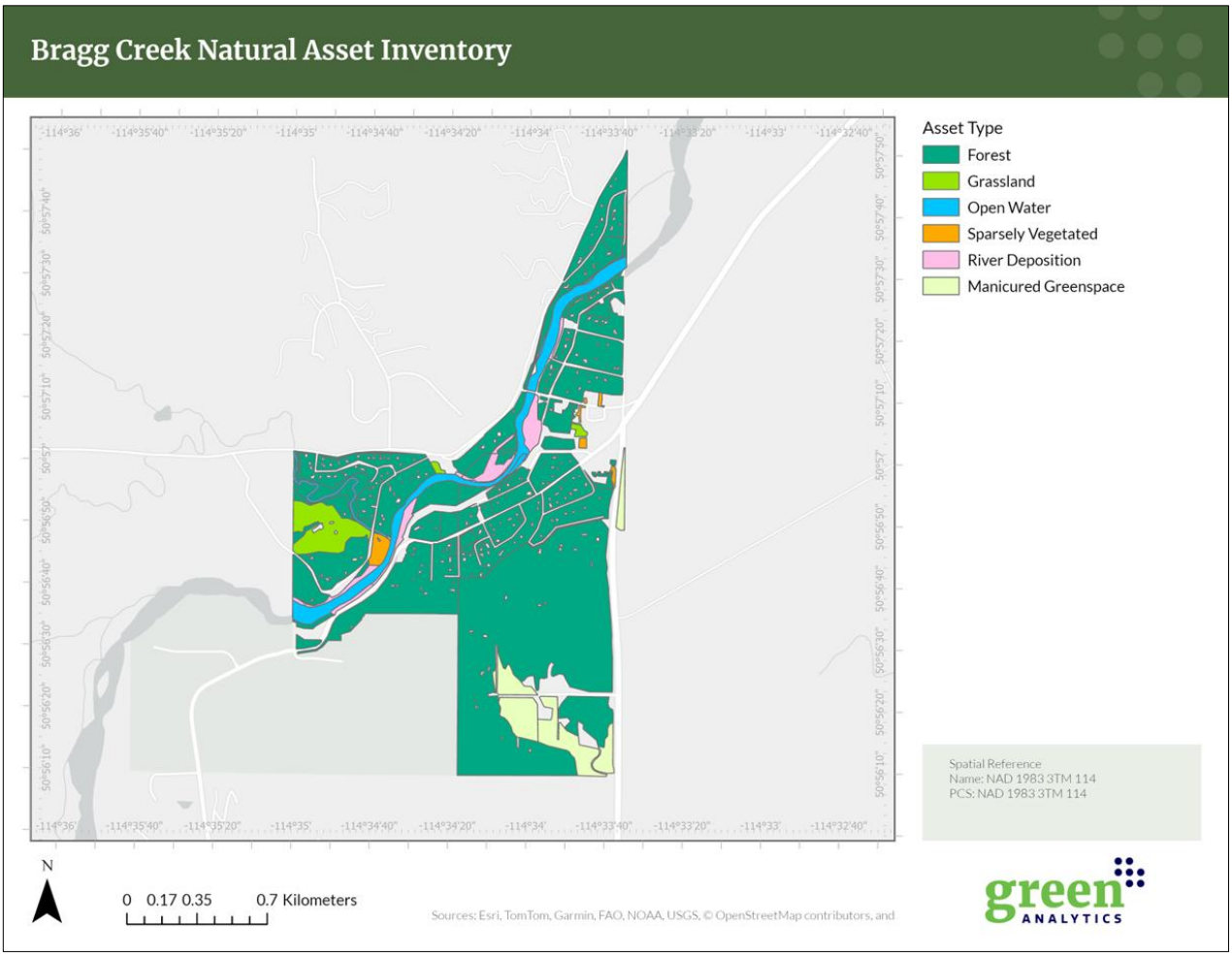



**Figure 3-3**. Natural and enhanced assets in Bragg Creek Hamlet Growth Area, by asset type.

Table 3-2 demonstrates the breakdown of asset classes, types and sub-types by area along with their percent contribution to the total study area.

**Table 3-2**. Assets in Bragg Creek Hamlet Growth Area by class, type, and subtype.

| Asset Class | Asset Type | Asset Sub-type | Area (ha) | % |
|---|---|---|---|---|
| Natural | Forest | Coniferous | 63.15 | 29.88% |
| | | Deciduous | 0.10 | 0.05% |
| | | Mixed | 108.27 | 51.23% |
| | Grassland | | 7.16 | 3.39% |
| | River Deposition | | 5.92 | 2.80% |
| | Open Water | River | 11.69 | 5.53% |
| | | Stream | 1.06 | 0.50% |
| | Sparsely Vegetated | | 1.88 | 0.89% |
| Enhanced | Built-up Pervious | Manicured | 12.11 | 5.73% |
| Total | | | 211.34 | 100.00% |

Figure 3-4 provides a breakdown of natural versus enhanced assets along with their associated ownership. The outer ring represents the total area of natural and enhanced assets, which together amount to 211.34 ha. Natural assets comprise the vast majority (199 ha, or 93%) of the total area, while enhanced assets

account for 12 ha (7% of the total).[2] The inner ring of the figure categorizes the asset classes by ownership. Of the natural assets, 13.4 ha (6% of the total area of natural assets) are owned by Rock View County, while the remaining 185.8 ha (94% of the total area of natural assets) are owned by private or other entities. Enhanced assets, on the other hand, consist of 1 ha (8% of the total area of enhanced assets) owned by private or other entities, with no ownership assigned to the remaining 11.1 ha (92% of the total area of enhanced assets).

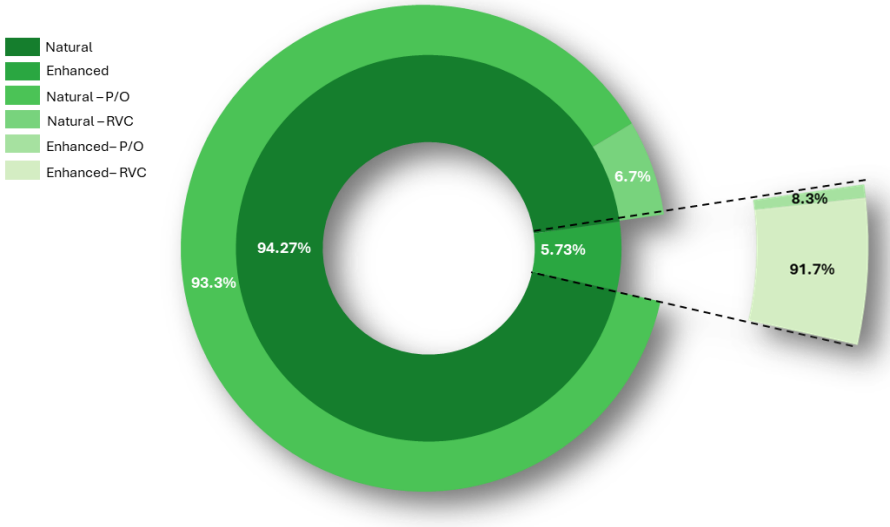



**Figure 3-4**. The composition of assets in Bragg Creek Hamlet Growth Area by natural and enhanced asset types and ownership. The inner ring shows the total percentage of natural and enhanced assets within the Bragg Creek Hamlet Growth Area, while the outer ring further subdivides these assets into County-owned and other ownership types.

Table 3-3 summarizes ownership information by asset type. Of the total area of natural assets (199.24 ha), 6.7% (or 13.43 ha) are County-owned with the majority of these being forest. The significant private ownership of these natural assets speaks to the importance of collaboration with other landowners to ensure continued service provision from the assets within the Hamlet Growth Area boundary.

[2] Note that built up areas are not included in the asset inventory. Some such areas do have natural features associated with them. However, if such natural features are not reflected in the spatial data employed to delineate the assets for the purposes of the inventory, they will not be captured in the inventory.

**Table 3-3.** Asset type summary for all and county-owned natural assets.

| Asset Type | Total (ha) | Percentage of Private/Other Ownership | County-owned Area (ha) | Percentage of County-owned Area | No ownership Assigned |
|---|---|---|---|---|---|
| **Natural** | | | | | |
| Forest | 171.52 | 93.8% | 10.67 | 6.2% | - |
| Grassland | 7.16 | 99.4% | 0.04 | 0.6% | - |
| River Deposition | 5.92 | 77.9% | 1.31 | 22.1% | - |
| Open Water | 12.76 | 89.9% | 1.29 | 10.1% | - |
| Sparsely Vegetated | 1.88 | 93.7% | 0.12 | 6.3% | - |
| Total Natural | 199.24 | 93.3% | 13.43 | 6.7% | - |
| **Enhanced** | | | | | |
| Built-Up Pervious | 12.11 | 8.3% | | | 91.7% |
| Total Enhanced | 12.11 | 8.3% | | - | 91.7% |
| Total Asset | 211.34 | 88.4% | 13.43 | 6.4% | 5.3% |

Replacement cost analysis approximates the monetary cost required to restore or re-create natural assets if they are damaged or destroyed. Although the Bragg Creek Hamlet Growth Area's natural asset inventory includes features like river deposition, open water, and sparsely vegetated areas, these were excluded from the replacement cost analysis due to either the absence of well-established unit cost estimates for restoring these features or limited feasibility to fully replace these assets.

Table 3-4 presents the estimated replacement cost for forest and grassland assets within the Bragg Creek Hamlet Growth Area. Unit replacement costs were sourced from Credit Valley Conservation (CVC), representing a first cut at establishing restoration costs. These values should be revisited once more robust Alberta-specific costs become available. The unit values represent the cost of restoring or re-creating 1 ha of each asset type. Applying these unit rates to the corresponding asset area results in an estimated replacement value of $37.04 million for forest assets and $1.32 million for grassland assets.

**Table 3-4.** Replacement cost for selected natural assets in the Bragg Creek Hamlet Growth Area.

| Asset Type | Asset Area (ha) | Unit Replacement Cost ($) | Replacement Cost (million $) |
|---|---|---|---|
| Forest | 171.52 | 214,959[1] | 37.04 |
| Grassland | 7.16 | 184,635[2] | 1.32 |

Note:
1: cost of creation of 1 ha of deciduous or mixed forest, from CVC
2: cost of creation of 1 ha of cultural meadow, from CVC

# 4 Condition Assessment

A condition assessment was conducted for the Bragg Creek Hamlet Growth Area's natural assets. This section provides an overview of the condition assessment approach and results. Additional details are provided in Appendix B.

## 4.1 Approach Overview

A natural asset condition assessment aims to evaluate a natural asset's ability to provide services at a high level. This approach uses the cascade model outlined in CSA (2023), which links biophysical processes, function, ecosystem services, and human benefits (Figure 4-1). For instance, a wetland's biophysical processes enable water storage, which reduces flood risks and provides human benefits by minimizing flood damage. Condition indicators capture ecological condition and connect it to ecosystem services and community value. The assessment is based on the assumption that a natural asset in "good" ecological condition is more likely to deliver a "good" level of ecosystem services.

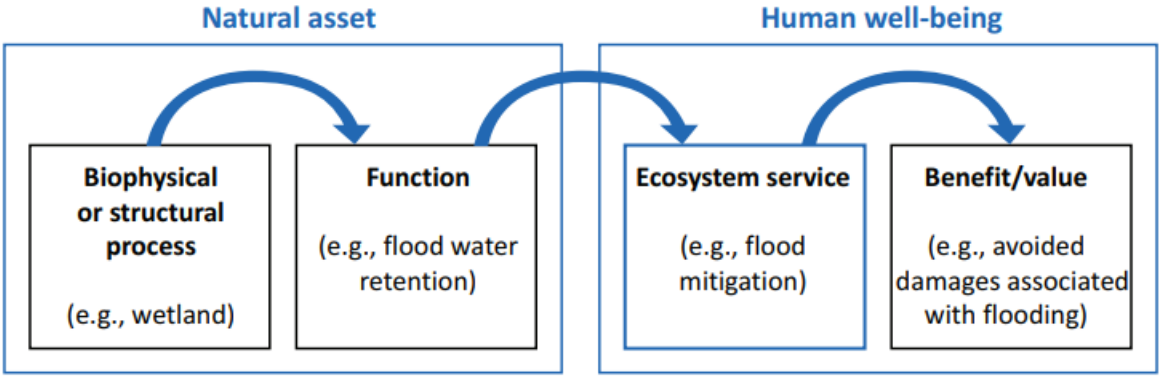



**Figure 4-1.** Cascade model upon which the condition assessment is based (CSA 2022).

The process used for the condition assessment aligns with that outlined in the Canada-wide standards and specifications for natural asset inventories (CSA 2022). The standard provides guidance on condition assessment criteria, indicators and scoring in the context of natural assets. The standard identifies three criteria - landscape context, physical context and ecological condition – to guide the selection of indicators. For each of the indicators, a scoring system is established to allow the results of the assessment to be positioned within a standardized 5-point ranking system ranging from very good to very poor. While a specific scoring system is needed for each individual indicator (see Appendix B for details), the scores generally align with the condition descriptions presented in Table 4-1.

**Table 4-1**. Sample condition rating scale definitions (CSA 2023).

| 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. |

The first step in the condition assessment was to identify a set of relevant condition indicators. Based on past project experience, Green Analytics identified a preliminary set of potential indicators. Draft results were reviewed by Rocky View staff as well as project team members and were revised according to feedback received. The condition indicators are noted below and categorized into three criteria (i.e., landscape context, physical context, and ecological condition) to align with the CSA standard for natural asset inventories.

CRITERIA FOR PHYSICAL CONTEXT

1. Natural asset proximity to watercourses
2. Forest Proximity to other natural assets

CRITERIA FOR LANDSCAPE CONTEXT

3. Road density
4. Extent of adjacent permeable land uses

ECOLOGICAL CONDITION

5. Interior habitat
6. Natural area patch shape
7. Open water riparian

The condition indicators were applied to the natural assets within the Bragg Creek Hamlet Growth Area boundary (Table 2-1) through a desktop exercise relying on GIS. Details on the approach employed for each indicator are provided in Appendix B. The desktop condition assessment completed for the natural assets is grounded in landscape ecology metrics; it is nonetheless recommended that field-based verification of the condition of the natural assets be completed over time to support and improve natural asset condition monitoring. Field-based condition assessments provide details and information on the condition of assets as well as the factors contributing to the condition results. Observations of habitat structure and complexities, risks (e.g. invasive species) and factors contributing to service delivery (e.g. encroachments) can be obtained

through field-based assessments. A standard for field-based condition assessments for natural assets does not currently exist. However, the Natural Assets Initiative's guidance document on natural asset management references a rapid condition assessment developed by the Credit Valley Conservation Authority in Ontario (NAI 2024). The assessment is intended to guide the efficient collection of field data to inform natural asset management. Field-based condition assessments of natural assets can be completed on a pre-determined schedule over several years starting with high priority areas (e.g. those at high risk, those with high service delivery, those suspected to be in poor condition). Condition assessments can also be pursued as part of land use planning as areas flagged as environmentally sensitive require a professional to assess and verify the presence of sensitive areas on-site before development can proceed.

## 4.2 Summary of Condition Assessment Results

This section of the report summarizes the results of the GIS-modelling desktop condition assessment. The indicator results were combined to derive an overall condition score for each of the natural assets within the inventory. This was done by averaging the scores across the indicators assuming equal weight for each indicator. The spatial distribution of the amalgamated condition result is depicted in Figure 4-2. As is demonstrated in the figure, the asset conditions are rated as good, fair, or poor. No assets were found to be in very good or very poor condition.

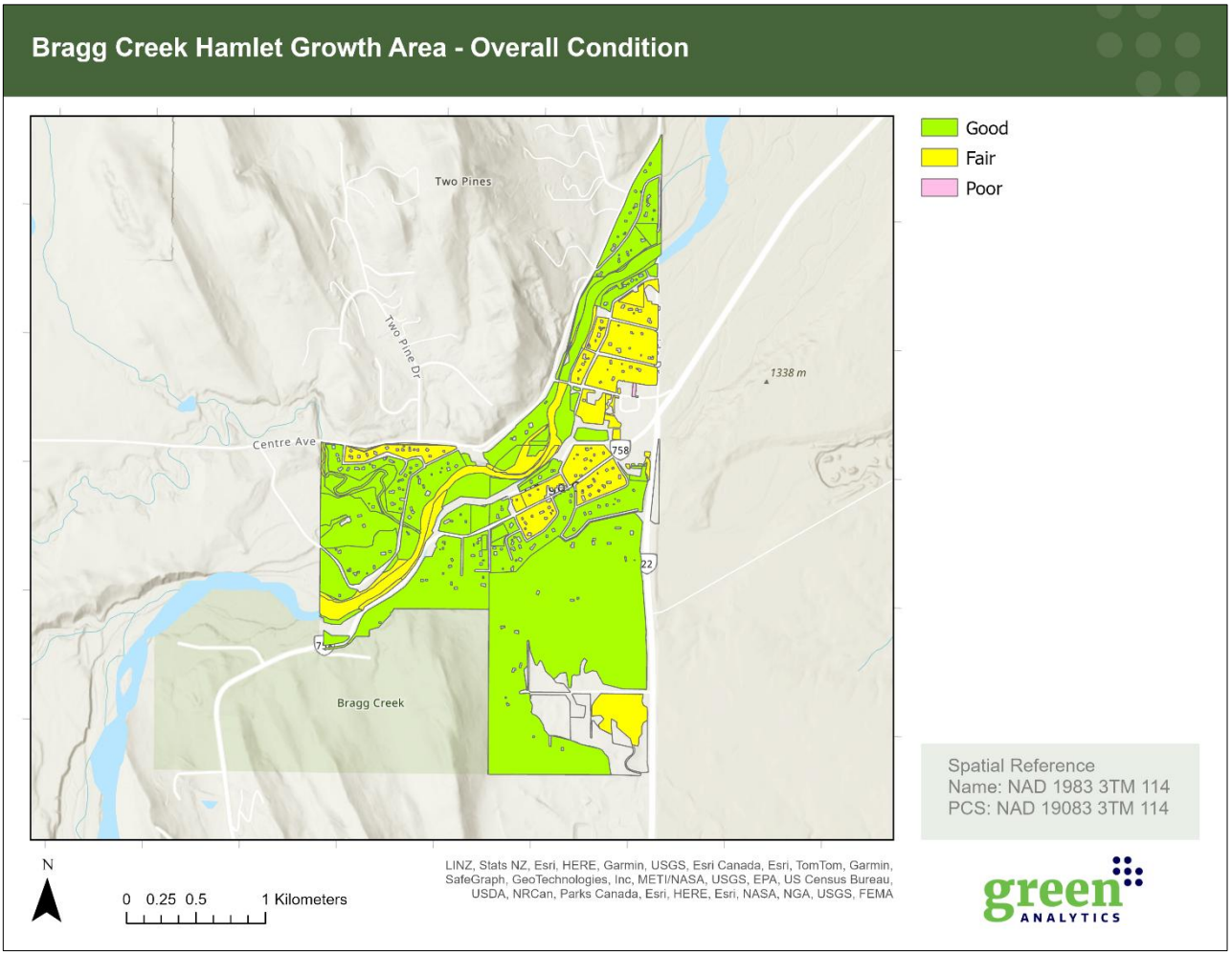



**Figure 4-2**. Overall condition rankings for the Bragg Creek Hamlet Growth Area's natural assets.

According to the indicators employed in this assessment, the majority of the Bragg Creek Hamlet Growth Area's natural assets are in good condition (78%). A high portion of assets are in fair condition (22%) and only a small portion of assets are in poor condition (<1%) (Figure 4-3). These results are useful for informing high level management actions but are not, on their own, sufficient to prescribe specific management actions for particular assets. Good and very good condition results indicate assets that may be appropriate for conservation or protection. Fair, poor and very poor condition results signal assets that may be appropriate for restoration or enhancement. To confirm specific actions for particular assets, as per natural asset management, the condition results should be: a) verified through field based assessments, b) considered along with applicable risks, c) evaluated for the services they deliver, and d) examined in light of community priorities and strategic objectives.

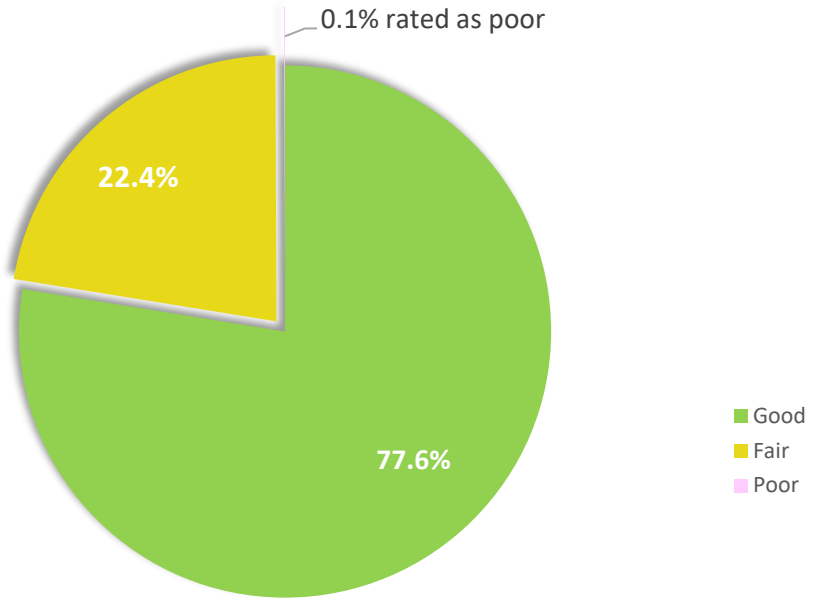



**Figure 4-3**. Summary of natural assets by condition ranking.

It is informative to consider the condition results by asset type to better understand the implications for asset management. Figure 4-4 shows the breakdown of condition ranks across the range of natural asset types within the inventory. Overall, the vast majority of assets rank good and fair. Relatively speaking, the asset types with the highest proportion of good condition assets include grassland (95% ranked good) and forest (81% ranked good) assets. From a management perspective, the focus for these assets is on maintaining their condition, particularly in the face of potential risks. River deposition, and open water had the highest percentages of fair condition rating (71%, and 60%, respectively), which suggests prioritization of these asset types for further assessment as well as potential enhancement and restoration activities. The poor condition rating is associated with minor amounts of sparsely vegetated lands.

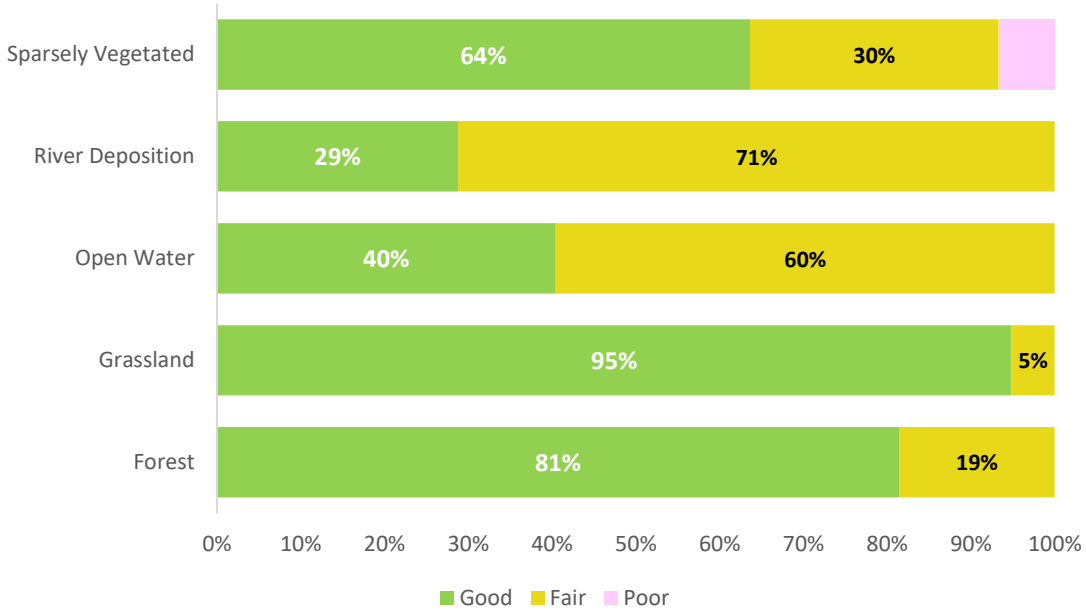



**Figure 4-4**. Condition rankings by natural asset type.

Figure 4-5 illustrates the breakdown of forest and grassland replacement costs in the Bragg Creek Hamlet Growth Area by condition rating. The left pie chart represents the replacement cost distribution for forest assets, with 81%, or $30.16 million attributed to forested areas in good condition and 19%, or $6.88 million, associated with forest areas in fair condition. The right pie chart shows a similar distribution for grassland assets, where 95% ($1.25 million) of the replacement cost corresponds to grasslands in good condition and only 5% ($0.07 million) to those in fair condition.

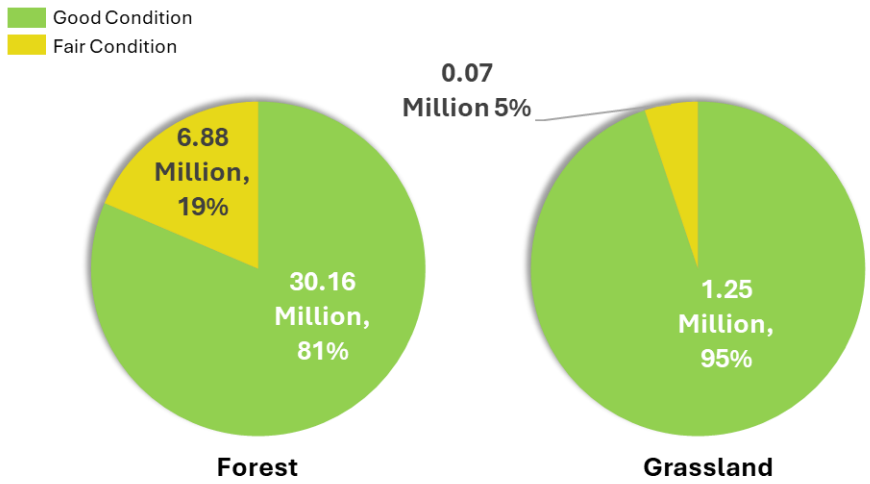



**Figure 4-5.** Replacement costs for forest and grassland assets by condition rating.

# 5 Risk Assessment

This section provides details on the risk profiling exercise undertaken as part of the natural asset inventory project for the Bragg Creek Hamlet Growth Area.

Natural assets can withstand a certain amount of stress without failing and in many cases when such assets are damaged, they can "self-repair" over time. Further, degradation or damage to one component of a natural system may not have a significant impact on the overall level of service provided by that asset (e.g., loss of one tree will likely have a minor impact on the overall services provided by a forest asset). This is true if the damage is not too severe or sustained, and if the asset is not subject to a succession of stressors or already in poor condition. This resilience is one of the many reasons natural assets have been identified as helpful when responding to certain infrastructure and climate change related challenges. Nonetheless, cumulative impacts and / or exposure to multiple stressors can cause even the most resilient natural assets to reach tipping points that can cause cascading or widespread failure of the assets. To account for this possibility, natural asset risk assessments consider the likelihood and impact of a range of hazards that can negatively impact natural assets.

The objective of the risk profiling exercise was to identify and rank a range of hazards that may negatively impact the provision of service delivery or the performance (quality/condition, function or capacity) of natural assets. Specifically, the focus of the assessment was on the likelihood of hazards occurring and the impact such hazards could have on natural assets. This is, and should be viewed as, distinct from the consequence of failure and probability of failure of an asset, which are sometimes considered when conducting a risk assessment of built assets.

## 5.1 Overview of the Risk Profiling Process

The risk profiling exercise involved the following steps:

1. Identify the range of potential hazards.
2. Rank the impact of each hazard.
3. Rank the likelihood of each hazard.
4. Calculate an overall risk score (impact * likelihood).

To complete the risk profiling for Bragg Creek, a workshop was undertaken with representatives from Rocky View County and local environmental groups. See Appendix C for a list of participants. The sections that follow provide an overview of each step in the hazards-based risk assessment exercise.

### 5.1.1 Identify the Range of Potential Hazards

The first step in the exercise was to identify the range of hazards that could negatively impact Bragg Creek's natural assets. During the workshop, the project team presented participants with a list of potential hazards. The list was discussed and refined based on the local knowledge and expertise of the collective group. Relevant hazards identified for the Bragg Creek Hamlet Growth Area include:

- Invasive species
- Pests and disease
- Illegal dumping

- Edge encroachments / unauthorized development
- Flooding
- Erosion
- Sediment deposition
- Extreme wind
- Contamination / Pollution
- Fire
- Inappropriate or overuse (e.g. trail braiding, unauthorized trails, dogs off leash)

### 5.1.2 Rank the Impact of Each Hazard

The second task in the workshop was to assign an impact score to each hazard on a scale of 1 to 5, where 1 is very low impact and 5 is very high impact. Table 5-1 contains impact rating criteria used as the basis for allocating impact scores; the criteria consider financial, socio-economic, and environmental impacts.

**Table 5-*1***. Rating the impact of hazards on natural assets.

| Scale | Impact | Financial | Socio-economic | Environmental |
|---|---|---|---|---|
| 5 | Very High | Cost of remediation exceeds annual budget > 100 times | Permanent loss of related services | Potential to cause long term environmental damage to the condition of the natural assets. |
| 4 | High | | | |
| 3 | Moderate | Cost of remediation exceeds annual budget > 10 times | Temporary loss of related services. | Potential to cause short term repairable environmental damage to the condition of the natural asset over a large area. |
| 2 | Low | | | |
| 1 | Very low | Cost of remediation falls within annual budget | Little to no effect on related services | Potential to cause non-lasting damage to environmental assets. |

### 5.1.3 Rank the Likelihood of Each Hazard

In addition to an impact score, for each hazard a likelihood score was allocated on a scale of 1 to 5, where 1 is rare and 5 is almost certain. Table 5-2 provides a summary of the likelihood ratings that were used as a reference to help assign the ratings. In this context, the focus of the likelihood scoring was on how likely or how frequent each hazard's impacts are anticipated to occur.

**Table 5-2.** Rating the likelihood of hazards on natural assets.

| Scale | Likelihood | Description | Annual probability | Return period |
|---|---|---|---|---|
| 1 | Rare | Likely to occur once every 50 years or less | Less than or equal to 2% | 1:50 or less |
| 2 | Unlikely | Likely to occur between once every 21 years and once every 50 years | 2 to less than 5% | 1:21 to 1:50 |
| 3 | Possible | Likely to occur between once every 5 years and once every 20 years | 5 to less than 20% | 1:5 to 1:20 |
| 4 | Likely | Likely to occur between once every 2 years and once every 5 years | 20 to less than 50% | 1:2 to 1:5 |
| 5 | Almost certain | Likely to occur annually or several times per year | Greater than or equal to 50% | 1:1 or more |

It is worth noting that not all the hazards described above in section 5.1.1 are event-based with a specific return period. Some hazards (e.g. invasive species, or overuse) are more continuous and slowly build over time. In these cases, likelihood considerations were based on the annual probability that the defined impact occurs over the next 5 to 10 years in the absence of active management.

### 5.1.4 Calculate the Risk Score

Once each hazard was rated for impact and likelihood, an overall risk score for each hazard was generated by multiplying the impact score by the likelihood score. Table 5-3 demonstrates how the impact and likelihood ratings translate into an overall risk score that can be ranked on a scale from very low to very high.

**Table 5-3.** Combining the impact and likelihood ratings into an overall risk score.

| | | Impact | | | | |
|---|---|---|---|---|---|---|
| | | **1 Very low** | **2 Low** | **3 Moderate** | **4 High** | **5 Very high** |
| **Likelihood** | **5 Almost certain** | Low 5 | Moderate 10 | High 15 | Very high 20 | Very high 25 |
| | **4 Likely** | Low 4 | Moderate 8 | Moderate 12 | High 16 | Very high 20 |
| | **3 Possible** | Low 3 | Low 6 | Moderate 9 | Moderate 12 | High 15 |
| | **2 Unlikely** | Very low 2 | Low 4 | Low 6 | Moderate 8 | Moderate 10 |
| | **1 Rare** | Very low 1 | Very low 2 | Low 3 | Low 4 | Low 5 |

## 5.2 Hazards-based Risk Assessment Results

This section summarizes the risk profiling outputs for the Bragg Creek Hamlet Growth Area.

Table 5-4 provides a summary of the impact, likelihood and overall risk scores for the hazards. The highest risk hazards that could negatively impact Bragg Creek's natural assets are fire, flooding, pests and disease, and extreme wind.

**Table 5-*4*.** Hazards-based risk results for Bragg Creek's natural assets.

| Potential Hazards to Natural Assets | Impact Rating | Likelihood Rating | Risk Score |
|---|---|---|---|
| Invasive Species | 2 | 5 | 10 |
| Pests and Disease | 3 | 5 | 15 |
| Illegal Dumping | 3 | 1 | 3 |
| Edge Encroachment / Unauthorized Development | 3 | 3 | 9 |
| Flooding | 4 | 4 | 16 |
| Erosion | 3 | 3 | 9 |
| Sediment Deposition | 2 | 1 | 2 |
| Extreme Wind | 3 | 5 | 15 |
| Contamination / Pollution | 5 | 1 | 5 |
| Fire | 5 | 5 | 25 |
| Inappropriate Use or Overuse (e.g., Trail Braiding, Unauthorized Trails, Dogs Off Leash) | 3 | 4 | 12 |

A number of observations were shared during the workshop that are worth noting here:

1. The impact of invasive species on sensitive habitats such as the Bragg Creek Orchid and Wildlife reserve could be higher than is reported above.
2. The impact of invasive species on spruce trees in the Bragg Creek area is an example of this hazard; monoculture forests that are characteristic of the Bragg Creek area increase the vulnerability to this hazard.
3. Edge encroachments and unauthorized developments include building prior to obtaining the necessary permits and draining wetlands and waterways for developments.
4. Erosion impacts are triggered by development along waterways and tributaries, sometimes occur without proper permitting.
5. Contamination / pollution was noted as a hazard that could specifically impact aquifers.

Given the risk profile for the Bragg Creek Hamlet Growth Area natural assets, a number of management actions can be considered. Given the high portion of privately owned natural assets within the Growth Area boundary, actions targeted at private land-owners should be high priority. Table 5-5 identifies potential risk management actions (some of which Rocky View County may already do) given the hazard profile of the Bragg Creek Hamlet Growth Area.

**Table 5-5.** Management considerations for Bragg Creek Hamlet Growth Area.

| Potential Hazards to Natural Assets | Management Considerations | Potential Risk Management Actions |
|---|---|---|
| Invasive Species | Sensitive habitats (e.g., Orchid and Wildlife Reserve) are at elevated risk. Spread is exacerbated by trail use, soil disturbance, and gardening practices. | Develop a local invasive species watch program with landowner participation.<br><br>Offer incentives for removal (e.g., subsidized weed pulls, native plant giveaways).<br><br>Targeted outreach for properties near priority habitats. |
| Pests and Disease | Monoculture spruce forests are highly vulnerable, especially to regional pests (e.g., spruce beetle). | Promote forest diversification and mixed-species plantings through private landowner education.<br><br>Provide cost-sharing for selective thinning or replacement plantings.<br><br>Encourage regular health assessments of forested parcels. |
| Illegal Dumping | Often occurs on private property boundaries, vacant parcels, or near trail access points. | Increase enforcement and signage at known dumping hotspots.<br><br>Organize community clean-up events and report-a-dumper programs.<br><br>Consider fencing or natural barriers on private land where dumping is chronic. |
| Edge Encroachment / Unauthorized Development | Includes building without permits and wetland drainage; occurs along forest edges and waterways. | Strengthen enforcement of permitting processes, especially for riparian zones.<br><br>Offer a landowner stewardship guide with clear do/don't rules. |
| Flooding | Riparian areas and infrastructure near waterways are exposed; some development occurs within high-risk zones. | Promote natural buffers along streams through conservation easements or bylaws.<br><br>Develop a targeted floodplain management policy for private lands.<br><br>Encourage riparian restoration on properties in priority flood zones. |
| Erosion | Triggered by development near creeks and slopes, sometimes without permitting. | Require erosion control plans as part of development approvals.<br><br>Support native vegetation planting on vulnerable slopes (landowner cost-share).<br><br>Map high-risk erosion zones and provide landowner notifications. |
| Sediment Deposition | Downstream effects from upstream clearing and soil exposure. | Introduce low-impact development (LID) practices and guidelines for private lots. |

| Potential Hazards to Natural Assets | Management Considerations | Potential Risk Management Actions |
|---|---|---|
| | | Encourage retention of riparian vegetation on all parcels near streams. |
| Extreme Wind | Can damage monoculture forests, especially spruce. | Promote shelterbelts and multi-layered canopy structures on private forest parcels.<br><br>Use blowdown mapping to target vulnerable areas.<br><br>Encourage deadfall removal where fire risk overlaps with windthrow zones. |
| Contamination / Pollution | Aquifer vulnerability due to septic systems, runoff, and improper disposal. | Conduct well and septic education campaigns for landowners.<br><br>Provide subsidized water testing and septic inspections.<br><br>Identify and prioritize recharge zones for protection or landowner incentives. |
| Fire | High-risk due to forest cover, recreational use, and scattered development. | Create a FireSmart program tailored for private landowners.<br><br>Enforce defensible space requirements through local bylaws.<br><br>Develop a community wildfire protection plan with parcel-level risk guidance. |
| Inappropriate Use / Overuse (e.g., trail braiding, unauthorized trails, dogs off leash) | Impacts biodiversity, vegetation, and soil stability. | Establish formal trail network and decommission rogue trails.<br><br>Expand education campaigns targeting dog owners and recreational users.<br><br>Use signage, fencing, and outreach programming to promote responsible recreation. |

# 6 Ecosystem Services Valuation

This section summarizes the results of the ecosystem services valuation for the Bragg Creek Hamlet Growth Area.

## 6.1 Defining Ecosystem Services

Ecosystem services are the benefits that nature provides to humans. Ecosystem services contribute to human well-being and economic health by providing clean air and water, food, materials for shelter and clothing, and natural resources for economic development. Additionally, these services play a crucial role in reducing environmental risks and regulating natural cycles in ways that sustain life (WWF Living Planet Report, 2016). Figure 6-1 depicts numerous ecosystem services categorized by the common service types: provisioning, regulating, supporting and cultural. Provisioning services are direct products derived from ecosystems such as food and water; regulating services result from natural processes like climate control and water regulation; supporting services are foundational services that are necessary for the provision of all other services such as soil formation and nutrient cycling; and cultural services capture things like recreational and spiritual benefits. The ecosystem services summarized in Figure 6-1 align closely with the classification used by The Economics of Ecosystem and Biodiversity (TEEB) which is aligned with the Millennium Ecosystem Assessment Framework that helped standardize the way we understand and assess ecosystem services.


**Figure 6-1.** Ecosystem services diagram (Source: WWF Living Planet Report 2016).

To understand the value of ecosystem services, it is important to conceptualize the link between an ecosystem's biophysical structure and function and the value humans derive from them. This is

demonstrated through the cascade model presented in Section 4.1 (Figure 4-1). As per the cascade model, natural assets have biophysical structures and natural processes (e.g. wetland habitat and net primary productivity) that create ecosystem functions (e.g. slowing the passage of water). These functions generate the ecosystem services humans rely on (e.g. flood control) resulting in a benefit to humans (e.g. reduced flood risk). It is this benefit that a dollar value can be placed on (e.g. the value of avoided flood damages).

## 6.2 Ecosystem Services for Valuation

From the range of services identified in Figure 6-1, a number of priority ecosystem services were identified for the Bragg Creek Hamlet Growth Area. These were the focus of the valuation exercise. Valued services include aesthetics, air quality regulation, carbon sequestration, erosion control, water regulation and flood control, water purification and waste treatment, biodiversity habitat, nutrient cycling and soil formation (Table 6-1).

**Table 6-1.** Ecosystem services valued for the Bragg Creek Hamlet Growth Area.

| Ecosystem Service | | Focus of the Valuation |
|---|---|---|
| Cultural Services | Aesthetics | Value of aesthetic appreciation due to presence of natural assets. |
| Regulating Services | Air Quality | Avoided costs associated with health issues from air pollution. |
| | Carbon Sequestration | Value of carbon dioxide removed from the atmosphere. |
| | Erosion Control | Avoided costs of soil erosion and land degradation. |
| | Water Regulation and Flood Control | Avoided stormwater management infrastructure costs. |
| | Water Purification and Waste Treatment | Avoided water treatment costs through natural filtration by wetlands and soils. |
| Supporting Services | Habitat Provision | Value of maintaining land that supports suitable conditions for wildlife habitat. |
| | Nutrient Cycling | Contribution to soil fertility and ecosystem productivity. |
| | Soil Formation | Value of supporting long-term soil productivity and land use sustainability. |

The Bragg Creek Hamlet Growth Area benefits from regulating services including carbon sequestration and air quality regulation alongside erosion control and water regulation and purification functions. This area's forests and grassland perform essential functions such as carbon capture and storage as well as soil stabilization while they filter surface water and control runoff, which supports climate mitigation efforts, flood resilience and water quality protection. The ecological richness of the area make supporting services such as biodiversity habitat, nutrient cycling and soil formation highly relevant. The natural environment boosts cultural services through aesthetic enjoyment by offering scenic views.

Note that a value for recreation services is not included in the ecosystem service valuation for the Bragg Creek Hamlet Growth Area. While recreation is an important service provided by the natural assets surrounding the Growth Area, recreation user data was not available for the Bragg Creek Hamlet Growth Area. Such data is required to estimate the value of recreation services in a manner that aligns with the other service estimates provided in the study. Furthermore, there is no doubt that Bragg Creek benefits from the recreation services provided by the natural assets surrounding the Growth Area, however, very little

recreation takes place *within* the Growth Area boundary itself. For these reasons, this service was not valued as part of the current analysis.

Appendix D provides details on the approach employed to estimate the ecosystem services that were valued.

## 6.3 Ecosystem Service Valuation Summary

This section provides a summary of the overall valuation results. Appendix D provides results for each ecosystem service. The per ha values employed in the benefit transfer approach for the Bragg Creek Hamlet Growth Area are shown in Table 6-2. Values are presented by asset type for each of the services included in the valuation exercise.

**Table 6-2**. Bragg Creek Hamlet Growth Area per-ha values for ecosystem services by asset type.

| | Per-ha Value (2023 CAD$) | | | |
|---|---|---|---|---|
| Ecosystem Service | Forest | Grassland | Open Water | Sparsely Vegetated |
| Aesthetics | $1,144 | $1,004 | $935 | $1,004 |
| Air Quality | $762 | $124 | - | $124 |
| Carbon Sequestration[1] | $1,260 | $531 | - | $531 |
| Erosion Control | $793 | $81 | - | $81 |
| Water Regulation & Flood Control | $1,008 | $10 | $2,306 | $10 |
| Water Purification & Waste Treatment | $359 | $35 | $4,981 | $35 |
| Habitat Provision | $1,187 | $3,049 | $12 | $3,049 |
| Nutrient Cycling | $718 | $109 | $858 | $109 |
| Soil Formation | $25 | $11 | | $11 |
| Total | $7,256 | $4,955 | $9,092 | $4,955 |

1: Carbon Sequestration per-ha values are calculated based on SCC

Forest assets provide significant value on a per ha basis across the range of ecosystem services included in this analysis. The highest per ha rate for forest assets is for carbon sequestration. Other significant services are derived from habitat, aesthetics, and water regulation and flood control. Grassland and sparsely vegetated assets in the Growth Area are characterized by relatively higher per ha values for habitat and aesthetics. Notable services for open water bodies are water purification and waste treatment services and water regulation and flood control services.

Total ecosystem service values for each natural asset were derived by applying per-hectare values to the corresponding asset areas within the Bragg Creek Hamlet Growth Area. Given the per ha values for each natural asset type and the corresponding area of those assets, Figure 6-3 illustrates the spatial distribution of the total value by asset for the ecosystem services combined.

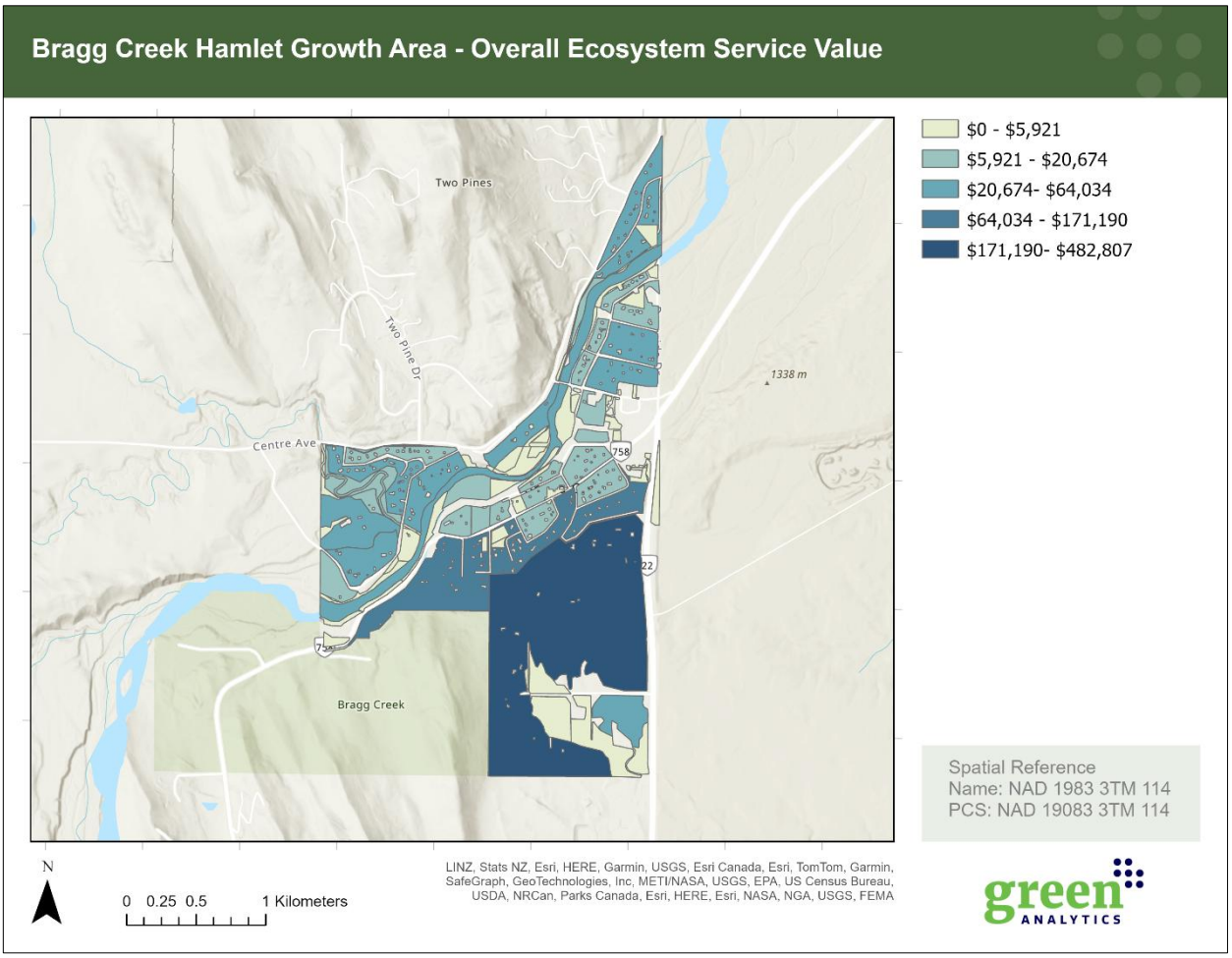



**Figure 6-32**. Bragg Creek Hamlet Growth Area total value of ecosystem services.

Table 6-3 contains annual ecosystem service values for the Bragg Creek Hamlet Growth Area. The total value of the services estimated through this study is $1.4 million annually. Forested areas represent the largest portion of the total value with an annual contribution of around $1.24 million. The large forest coverage across the Hamlet together with high forest per ha service values explains their dominant ecosystem service value. The forest lands deliver considerable annual benefits through carbon sequestration ($216,00), habitat provision ($204,000), aesthetic values ($196,000), and water regulation and flood control ($173,000). Grasslands, while contributing a smaller total value of $35,000 per year, contribute a substantial amount to habitat provision ($22,000). Hydrological and water quality functions provided by open water assets result in a total service value of $116,000 annually. These systems provide exceptional value in water purification and waste treatment ($64,000) and also deliver significant benefits for water regulation ($29,000) and nutrient cycling ($11,000).

**Table 6-3**. Value of ecosystem services by natural asset type.

| | Total Ecosystem Service Value by Natural Asset Type (2023 CAD$)[1] | | | |
|---|---|---|---|---|
| **Ecosystem Service** | **Forest** | **Grassland** | **Open Water** | **Sparsely Vegetated** |
| Aesthetics | $196,218 | $7,188 | $11,928 | $1,886 |
| Air Quality | $130,688 | $889 | - | $233 |
| Carbon Sequestration[2] | $216,113 | $3,796 | - | $996 |
| Erosion Control | $135,980 | $581 | - | $152 |
| Water Regulation & Flood Control | $172,871 | $74 | $29,410 | $20 |
| Water Purification & Waste Treatment | $61,629 | $253 | $63,534 | $66 |
| Habitat Provision | $203,563 | $21,818 | $158 | $5,726 |
| Nutrient Cycling | $123,148 | $778 | $10,947 | $204 |
| Soil Formation | $4,277 | $82 | - | $21 |
| **Sub-total** | **$1,244,487** | **$35,459** | **$115,978** | **$9,306** |
| **Overall Total** | **$1,405,229** | | | |

1: The numbers in the table are not rounded to ensure that all values across the range of magnitudes are represented, however, there is a margin of error associated with benefit transfer that is not reflected in the precise values presented. The value of services should be interpreted as within the order of magnitude of the numbers presented, not the specific number itself.

2: Carbon Sequestration per-ha values are calculated based on SCC

Figure 6-4 provides summary values of the services provided by the Bragg Creek Hamlet Growth Area by ecosystem service. Significant value is derived from habitat provision ($0.23 million per year), aesthetics and carbon sequestration (each of which deliver $0.22 million each year) and water regulation ($0.20 million per year).

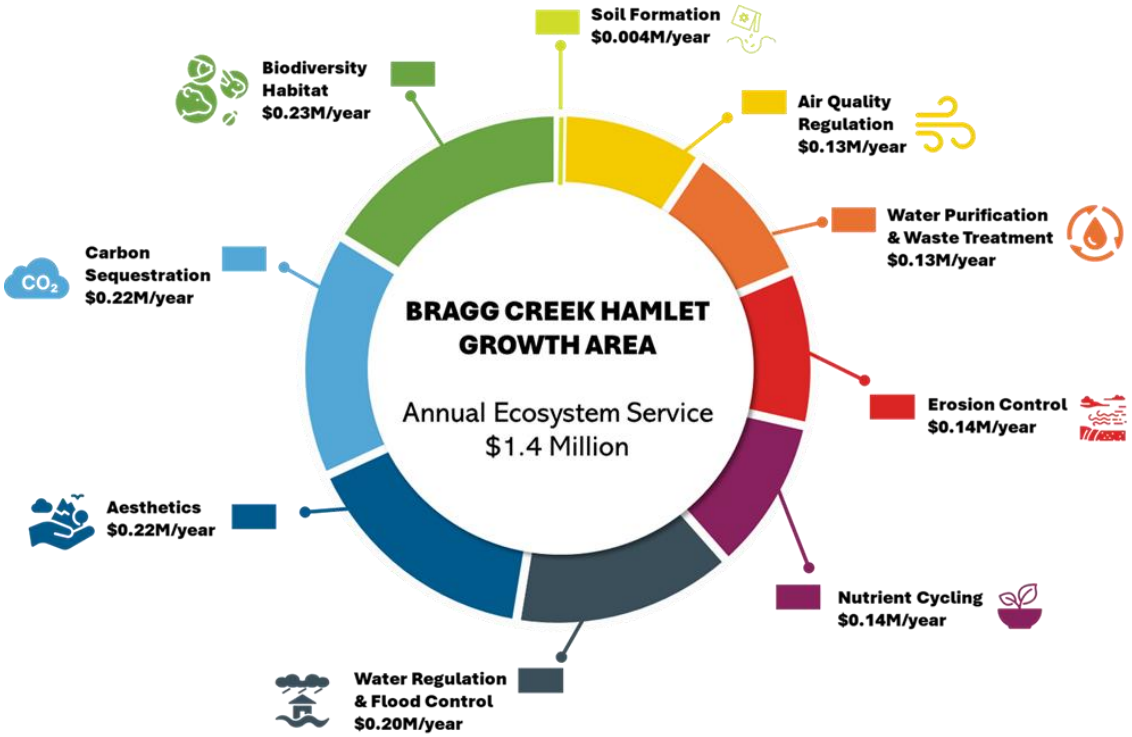



**Figure 6-43**. Summary of ecosystem service values by ecosystem service type for the Bragg Creek Hamlet Growth Area.

# 7 Summary and Recommendations

The *Bragg Creek State of Natural Assets Report* provides an assessment of the natural assets within the Bragg Creek Hamlet Growth Area in Rocky View County, Alberta. The report defines natural assets as features like forests, grasslands, and open water that deliver ecosystem services such as clean water, biodiversity support, flood mitigation, and carbon sequestration. The study aims to inform land use planning, especially the ASP Amendment Project, by quantifying the type, extent, ownership, condition, and replacement cost of natural and enhanced assets in the region. The inventory identifies 199 ha of natural assets (mostly forests) and 12 ha of enhanced assets, with the majority being privately owned. Estimated replacement costs are approximately $37 million for forests and $1.3 million for grasslands.

The report also includes a GIS-based desktop condition assessment using landscape ecology indicators such as interior habitat, road density, patch shape, adjacent permeable land use, and proximity to watercourses or other natural assets. Based on these indicators, most natural assets are in good (73%) or fair (21%) condition, with forests and grasslands scoring highest. These assessments help prioritize areas for conservation or restoration and should be refined by future field-based studies.

The valuation of ecosystem services reveals significant measurable benefits that arise from the natural assets within the Bragg Creek Hamlet Growth Area. By maintaining natural asset integrity, the region's forests, grasslands, water bodies and sparse vegetation generate an estimated annual value of $1.41 million. The ecosystem service valuation for Bragg Creek's hamlet and expansion area affirms that it's forests, wetlands, and open spaces provide substantial benefits that directly support the community's planning objectives. Rocky View County's plans stress managing growth in a way that preserves natural landscapes, maintains rural character, and enhances resilience. This evidence reinforces the need to keep natural assets intact as Bragg Creek grows.

The report establishes a basis for including natural assets in upcoming planning processes and policy development.

## 7.1 Opportunities to Maintain Condition and Protect Natural Assets

A key consideration in applying these findings is Bragg Creek's **land tenure**. The majority of the hamlet and especially the expansion area consists of privately owned parcels (about 86 hectares across roughly 20 parcels). This context means Rocky View County's direct regulatory control over land management is limited. Landowners ultimately decide how their properties are used within the broad allowances of zoning and bylaws. This presents a **challenge**: the County cannot unilaterally conserve forests or wetlands on private land or dictate land stewardship practices beyond what regulations require. For example, if a landowner chooses to clear trees on their property (assuming it meets bylaw and provincial rules), the County's influence is mostly indirect. This limited control could constrain the immediate implementation of ecosystem service protections – especially if development pressures incentivize land conversion.

This context also creates **opportunities** to engage and partner with landowners in innovative ways. The County can encourage voluntary measures and provide incentives to maintain natural assets on private land. The ASP itself recommends exploring voluntary conservation easements and stewardship agreements as tools to protect ecological values on private property.

Table 7-1 summarizes opportunities to maintain the condition of and protect natural areas from development that were identified in the policy and plan review directly (explicitly stated) or indirectly (the table provides examples of the opportunities identified in the documents). The table has been structured by theme with the hope this is a practical way of organizing the items and fosters meaningful implementation.

**Table 7-*1***. Opportunities to Maintain Condition and Protect Natural Assets from Development.

| Opportunity |
|---|
| **Environmental Reserves (ER)**<br>• Natural areas providing high value can be designated ER and can be acquired through an easement registered against the land title or through a designation of land.<br>• This reserve type is intended to remain in its natural state or can be used as a public park. The Hamlet should consider this **requirement as part of land use planning decisions** to remove deadfall to manage wildfire risk, particularly in the wildland-urban interface. |
| **Municipal Reserve (MR), School Reserve (SR), and Municipal and School Reserves (MSR)** Dedicated lands to be used as a public park, recreation area, school board purpose, or to buffer between different land use types.<br>• Ideally, the Hamlet should **require dedication of municipal reserves as land rather than cash in-lieu** of land when subdivision occurs to support habitat connectivity and water management, including other benefits.<br>• Maintenance of MR, SR, and MSR should seek to **keep areas naturalized** as much as practical to reduce long-term maintenance costs.<br>• **Co-operative initiatives** between the Hamlet, the school board, the local recreation board, local community associations, and neighbouring communities can be leveraged. Explore ways to protect and maintain connected open spaces and broaden recreational opportunities.<br>• **Maintain public open spaces in their natural "undisturbed" state** unless they are identified as active recreational amenities or face conditions that require intervention (e.g., risk of fire, invasive weeds, etc.). Signage and public communications campaigns can be used to explain the benefits of keeping areas naturalized. |
| **Land Use Bylaws, Development Permits, and Public Enforcement to Protect Nature**<br>• Land use bylaws and development permits can **regulate development** within riparian buffers, considering site design, coverage, grading, tree removal, landscaping, land use, setbacks, and flood proofing.<br>• Specific examples include: a **Tree Protection Bylaw** can restrict trees that can be removed and set maintenance requirements. Established forests have greater service value than those newly planted during landscaping. Requirements to use **specific plantings in landscaping** can support biodiversity. Vegetation bylaws must consider the risk of introducing invasive species to the surrounding environment.<br>• The public has expressed support for **increased enforcement to protect nature**. Bylaws related to trespassing on sensitive natural areas, littering, water pollution, etc. can protect natural areas. Public event permitting requirements can include environmental protection requirements. |
| **Land Acquisition**<br>Develop a Land Acquisition Strategy that considers areas, timing, financial commitments, policies, and specific lands that should be prioritized for acquisition (including encroachment buffers). Instruments to consider may include:<br>• **Land purchase** – the Hamlet purchases land at market value.<br>• **Conservation purchase** – a buyer purchases land at fair market value and pursues options related to donation, applying a conservation easement and reselling with the easement in place. |

| Opportunity |
| --- |
| • **Discounted sale** – landowner sells a conservation easement or property at less than full market value and donates the remaining value.<br>• **Conservation easement** – grantor agrees to undertake certain activities on a property and recipient commits some capital investment, annual payment, or annual activity that would allow the grantor to implement the terms of the agreement.<br>• **Gifts** of cash, securities, real estate, or life insurance – a tax receipt would be issued for the full amount of the gift.<br>• Including a recipient in a **will**.<br>• **Land donations** and **land swaps** |
| **Requirements and Incentives for Developers**<br>• Investigate development of a **policy for developers to share the cost** of creating and maintaining new parks, open spaces, and pathways.<br>• Evaluate creating **new requirements for developers** who wish to build residential buildings. The public expressed interest in a requirement for new subdivisions to be connected to an integrated pathway system. |
| **Pathway Network, Community Planning, and Public Engagement**<br>• **Expand the pathway network** to connect people with services (including nature-based recreation) throughout the community and the regional pathway network. Consider opportunities to locate paths within the road allowance, in response to public interest in this option. Pathways reduce the amount of infrastructure needed and impact to nature, cut down on vehicle use, and provide an amenity for the community.<br>• Work with surrounding communities and local organizations to **develop a pathway and park classification system**, including public signage and information on the program. This initiative can encourage people to keep their recreational activities within designated areas, providing benefits like maintaining water quality, protecting habitat, and reducing erosion.<br>• **Develop public-facing facilities in areas where people live** to reduce reliance on vehicles. This reduces vehicular traffic which can disturb wildlife, as well as the need for expanded infrastructure that infringes on natural areas. Pathways can further support this effort.<br>• Identify and develop **designated off-leash areas** for dogs. This will allow the Hamlet to reduce the number of people taking their dogs to environmentally sensitive natural areas, reducing impacts like vegetation disturbance, erosion, and water pollution.<br>• Provide **public education programs** designed to promote an understanding and participation in monitoring and managing natural areas. This can include topics like watershed and source water protection and FireSmart practices. |

## 7.2 Recommendations

To capitalize on this work and integrate nature's value into decision-making, **Rocky View County can pursue several next steps**:

1. **Examine the current policy framework:** Evaluate to what extent existing tools and policy mechanisms are being used to protect natural assets and how effective they are.
    - Seek opportunities to enhance and strengthen the utilization or enforcement of these strategies. This may include review and updates to the ASP (already underway), the Municipal Development Plan, Land Use Bylaws, and Development Permitting.
2. **Improve data and analysis:** Invest in better data collection and integration for natural assets.
    - For example, map and monitor wetlands, forest cover, wildlife habitat, and soil conditions in greater detail. Incorporate local studies (e.g. flood risk maps, wildlife surveys, citizen science data) to refine ecosystem service estimates.
    - Improved data will enhance accuracy and allow the County to update the inventory and valuation as conditions change. Periodic re-assessment (e.g. every 5 years) can track trends in ecosystem health and service values as development or restoration occurs.
3. **Establish a natural asset management plan (NAMP)** that aligns and integrates with Rocky View County's corporate asset management process.
    - The work completed in this report establishes the foundation (i.e. inventory, condition, replacement costs) necessary to start such an integration.
    - A NAMP can help document how the Hamlet wants to find a balance between preserving natural areas while reducing risk, as well as tracking how well assets are being managed.
4. **Integrate ecosystem services into planning and policy:** When reviewing development proposals or zoning changes in the Bragg Creek area, consult the ecosystem service values and local environmental expertise to identify high-value natural assets that merit protection or buffers.
    - Factor in nature's services when making land use decisions – for instance, preserving a wetland because it provides flood control and water filtration that would cost millions to replace with engineered infrastructure.
    - The ASP review offers a prime opportunity to embed policies on **environmental protection, recreation, and tourism** that are informed by this valuation. Ecosystem service data can also guide where **density or infrastructure upgrades** make sense versus where conservation should be prioritized.
    - By treating healthy ecosystems as a form of "green infrastructure," the County can plan growth that leverages natural services rather than undermines them.
5. **Nature-based infrastructure and climate resilience projects:** Use Bragg Creek as a demonstration area for nature-based solutions.
    - For example, the County could pilot a **riparian restoration project** along the Elbow River to enhance flood mitigation and fish habitat or expand the use of **naturalized stormwater management** (like bioswales or retention ponds that mimic wetlands). These pilot projects would show how investing in natural infrastructure yields dividends in risk reduction and public benefit.

- With climate change bringing heightened flood and wildfire risks, protecting and restoring natural defenses (wetlands, river floodplains, forest cover) should become part of the County's infrastructure strategy. The concept of natural assets contributing to infrastructure needs is gaining traction and should be explicitly linked to Bragg Creek's flood mitigation and resilience planning.
- Notably, if the **natural environment provides services that reduce the need for expensive built infrastructure, it's a win-win for the community's safety and finances**.

6. **Support private land stewardship and incentives:** Given the predominantly private land context, create programs that encourage landowners to conserve and enhance ecosystem services.
    - This could include **stewardship workshops** in Bragg Creek to share best practices (e.g. FireSmart forest management that also maintains habitat, or eco-friendly approaches to ranching and landscaping).
    - The County might establish a **recognition program** or small grants for landowners who set aside portions of their land for conservation (such as wetlands or wildlife corridors). Exploring **conservation easements** (legal agreements to protect natural land features) with interested landowners is another avenue.
    - Over time, building a culture of stewardship – perhaps through a local conservancy or landowner partnership network – will multiply the on-the-ground impact of the County's policies. The public engagement has shown Bragg Creek residents are proud of their natural surroundings, so tapping into that pride and turning it into concrete conservation actions will be key.

# 8 Appendix A: Data Sources

**Table 8-1.** Data sources and descriptions.

| Dataset | Use / Description | Source | Year |
|---|---|---|---|
| LULC | Inform the manual delineation and classification of natural assets in the study area | Government of Alberta | 2020 |
| Sentinel-2 Derived Land Classification | Inform the manual delineation and classification of natural assets in the study area | ESRI/Impact Observatory | 2023 |
| Building Footprints | Utilized for erasing built area from natural assets to improve accuracy of capturing only natural land | Microsoft | 2025 |
| Road Segments | Utilized for erasing non-natural area and within the condition assessment | Rocky View County | 2025 |
| Parcels (Ownership) | Used to assign the ownership attribute to assets | Rocky View County | 2025 |
| Hydropoly | Used to delineate the Elbow River as an asset | Rocky View County | 2025 |
| Surface Water | Used to delineate the stream leading into the Elbow River | Rocky View County | 2025 |
| Municipal Lands | Used for assigning the ownership attribute to assets | Rocky View County | 2025 |
| Floodway | Used to assign the floodway intersection attribute to assets | Rocky View County | 2025 |
| Flood (Fringe) | Used to assign the flood (fringe) intersection attribute to assets | Rocky View County | 2025 |
| Environmentally Significant Areas Scores | Used to calculate the mean ESA score for attributes | Alberta Parks | 2014 |
| Bull Trout Area | Used to assign the bull trout intersection attribute to assets | Department of Fisheries and Oceans | 2023 |
| Leopard Frog Area | Used to assign the leopard frog intersection attribute to assets | Alberta Environment and Parks | 2023 |
| Key Wildlife Area | Used to assign the key wildlife intersection attribute to assets | Fisheries and Wildlife Management Information System (FWMIS) | 2023 |
| Grizzly Support Zone | Used to assign the grizzly support zone intersection attribute to assets | Fisheries and Wildlife Management Information System (FWMIS) | 2023 |
| FWMIS Species Observations | Used to assign assets to species observations within the asset | Government of Alberta | 2024 |
| Rocky View Biophysical Attribute Rating Analysis | Used to assign the BAR score to assets | AgCanada | 2003 |
| Growth Hamlet Area | Used in delineation of the study area | Rocky View County | 2025 |

# 9 Appendix B: Condition Assessment Approach and Detailed Results

This appendix provides a description of the condition assessment indicators used in the GIS-based desktop spatial analysis to estimate the asset condition ranking presented in Section 4.

The condition indicators were combined to generate an overall condition score for each natural asset within the inventory (Figure 4-2). This was done by averaging the scores across the indicators assuming equal weight for each indicator.

## 9.1 Interior Habitat

INDICATOR: The relative size of contiguous natural asset areas with larger patches that have more interior area considered higher quality than smaller patches.

RATIONALE: The objective of this indicator is to create a proxy for condition, based on the relative size of contiguous patches of natural assets. In general, larger blocks of habitat (whether they be meadow, forest, and/or wetland) tend to support a greater diversity of plants and wildlife, including habitat specialists that require, or benefit from, conditions only found somewhat removed from a non-natural land cover type (e.g., roads, residential, institutional, or commercial development). In an urbanized context, as the distance from the edge of a natural area to the interior of that area decreases, the penetration of noise and other human-related disturbances and encroachments that can negatively impact certain species associated with those habitats increases.

APPROACH: "Interior" habitat – particularly in forest and woodlands - is typically measured by buffering inwards from the feature or "patch" edge. The first step was thus to establish the "patch" edge. The area within the inner boundary was then quantified. The quantification of interior habitat was applied to asset classes.

SCORING: Recognizing the landscape ecology principle that large "blocks" of habitat generally provide a greater range of better-quality habitats, a scoring system was developed based on whether interior habitat exists with varying distances from the habitat edge. Continuous patches of asset classes were used as the basis for this scoring.

**Table 9-1.** Condition ranking criteria for interior habitat.

| Condition Rating | Criteria |
|---|---|
| Very Good | An asset within a habitat patch with an interior area measured >200 m from the feature edge |
| Good | An asset within a habitat patch with an interior area measured 150-200 m from the feature edge and not already captured as "very good" |
| Fair | An asset within a habitat patch with an interior area measured 100-149 m from the feature edge and not already captured as "very good" or "good" |
| Poor | An asset within a habitat patch with an interior area measured 50-99 m from the feature edge and not already captured as "very good", "good", or "fair" |
| Very Poor | Any asset with no interior area measured at <50 m from the feature edge |

RESULTS: The following figures and table summarize the results of this condition indicator.

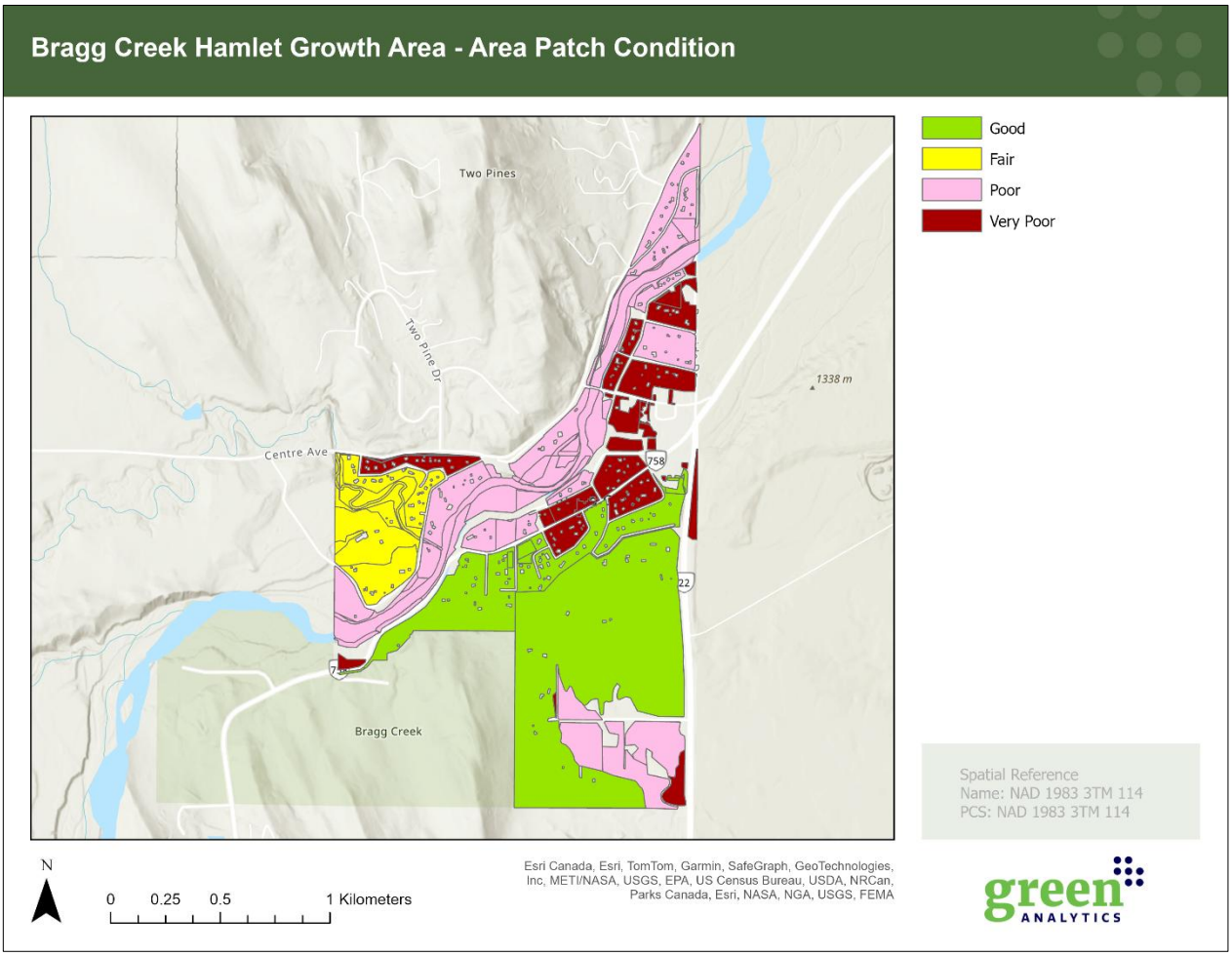
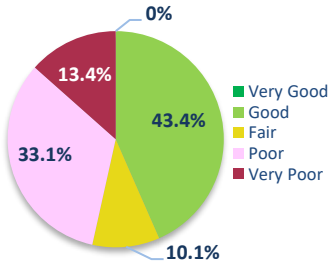



**Figure 9-1**. Condition assessment results for interior habitat.

**Table 9-2**. Condition assessment results for interior habitat.

| Condition Rating | Area (ha) | Percent of Total |
|---|---|---|
| Very Good | 0 | 0% |
| Good | 91.76 | 43.4% |
| Fair | 21.27 | 10.1% |
| Poor | 69.89 | 33.1% |
| Very Poor | 28.42 | 13.4% |



## 9.2 Road Density

INDICATOR: Density of roads within 120 m of the terrestrial natural assets, with higher road density ranking less favorably.

RATIONALE: Roads both adjacent to and within natural areas are known to cause negative impacts to natural features and their functions because they contribute directly to fragmentation, introduce noise and pollutants associated with vehicles, and provide vectors that facilitate human access to these features, which can result in additional encroachments and impacts (e.g., Environment Canada 2013; DeCatanzaro and Chow-Fraser 2010). The objective of this indicator is to capture the relative level of human use/activity occurring within and adjacent to natural features as reflected in road density.

APPROACH: To develop locally appropriate road density ranges aligned with the five condition score ratings (i.e., very good, good, fair, poor, and very poor) Alberta-based research was reviewed. For instance, Alberta's Grizzley Bear Recovery Plan recommends a road density limit of 0.6 km/km$^2$ in core areas and 0.75 km/km$^2$ in secondary access areas (Alberta Environment and Parks 2020). However, the thresholds are most appropriate when applied to a broader landscape scale such as a watershed. They are less applicable to a municipal context. The current study focuses on estimating road density in the immediate vicinity of natural assets located in a rural hamlet. For this reason, an alternative study was selected to inform the approach and scoring for Bragg Creek's condition assessment. Specifically, DeCatanzaro and Chow-Fraser (2010) was used to inform the relevant road density thresholds since it was based on buffering the sites of interest and correlating measures of condition with road densities. DeCatanzaro and Chow-Fraser (2010) demonstrate that for 77 marsh sites along the coast of lakes Erie, Ontario, and Huron that the water quality index (WQI) and wetland macrophyte index (WMI) scores were highly negatively correlated with surrounding road densities. Their results show the highest road density was 102 m/ha (or 10.2 km/km$^2$). Given the correlation to condition indices noted above, 10 km/km$^2$ was established as the threshold for very poor. Similarly, their lowest road density estimates for Lake Ontario 7.16 m/ha (or 0.72 km/km$^2$) was established as the threshold between good and very good. Other category thresholds are outlined below.

SCORING: Road density was assessed for areas within 120 m of the natural asset classes. Rankings were assigned as per the following table.

**Table 9-3**. Condition ranking criteria for road density.

| Condition Rating | Criteria |
|---|---|
| Very Good | 0 to 0.7 km/km$^2$ |
| Good | 0.8 to 2.9 km/km$^2$ |
| Fair | 3 to 6.9 km/km$^2$ |
| Poor | 7 to 10 km/km$^2$ |
| Very Poor | > 10 km/km$^2$ |

RESULTS: The following figures and table summarize the results of this condition indicator.

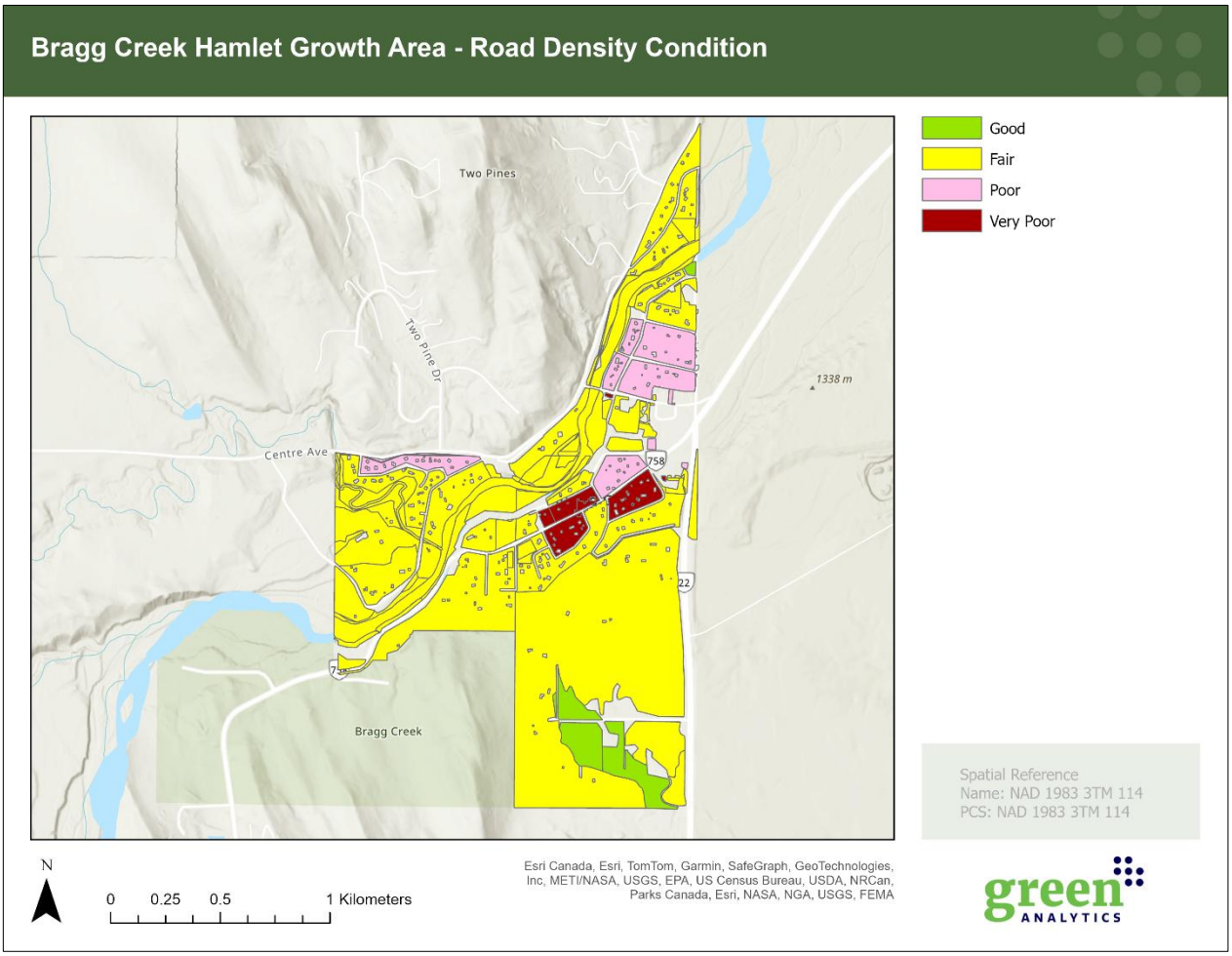
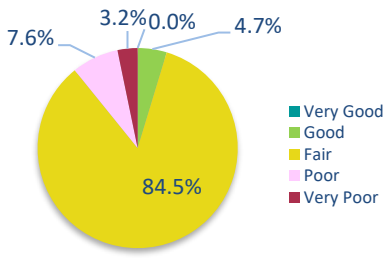



**Figure 9-2.** Condition assessment results for road density.

**Table 9-4**. Condition assessment results for road density.

| Condition Rating | Area (ha) | Percent of Total |
|---|---|---|
| Very Good | 0 | 0% |
| Good | 9.92 | 4.7% |
| Fair | 178.54 | 84.5% |
| Poor | 16.02 | 7.6% |
| Very Poor | 6.86 | 3.2% |



## 9.3 Natural Asset Patch Shape

INDICATOR: The shape of natural asset areas, with patches that are more round considered higher quality than smaller patches that are more linear.

RATIONALE: Many negative effects from human land uses occur at feature edges. Impacts at edges can include light and noise, access for invasive species, dumping, domestic animals and encroachment. Features with shapes that reduce the amount of edge are expected to have lower levels of potential edge effects. Given a certain size threshold, compact patch shapes should protect interior habitat against detrimental edge effects because these forms have low edge-to-interior ratios. Conversely, convoluted and elongated patches have high edge-to-interior ratios.

APPROACH: To determine the compactness ratio of an asset, the following formula was utilized:

sqrt (Area of patch / area of a circle with the same circumference (perimeter))

The resulting values are calculated as a value between or equal to 0 and 1, where 1 has the lowest possible edge to interior (a circle) and scores decrease as edge increases.

SCORING: The following table summarizes the condition scores based on compactness ratio:

**Table 9-5**. Condition ranking criteria for proximity to other natural assets.

| Condition Rating | Criteria |
|---|---|
| Very Good | >0.8 and ≤1.0 |
| Good | > 0.6 and ≤ 0.8 |
| Fair | > 0.4 and ≤ 0.6 |
| Poor | > 0.2 and ≤ 0.4 |
| Very Poor | ≤ 0.2 |

RESULTS: The following figures and table summarize the results of this condition indicator.

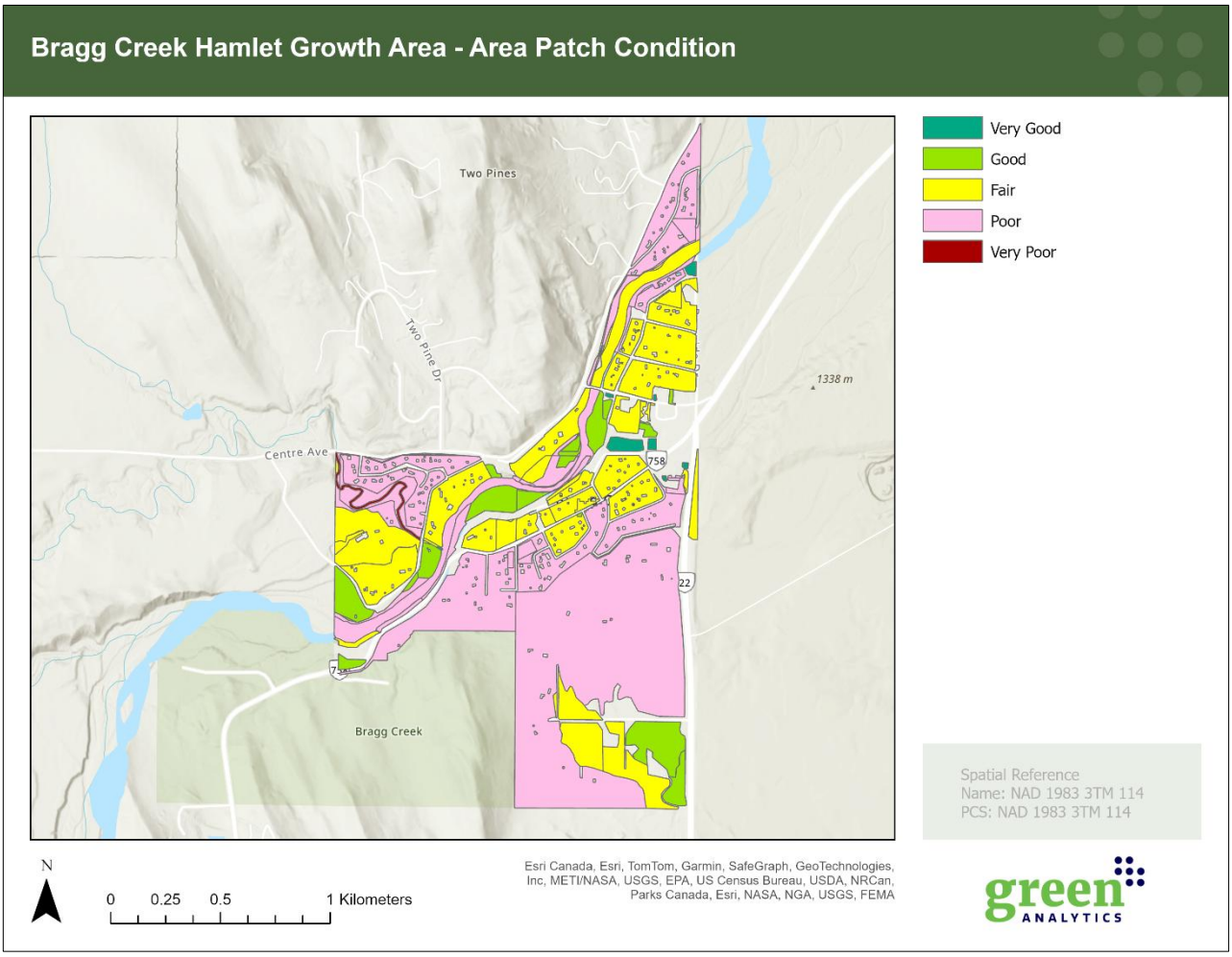
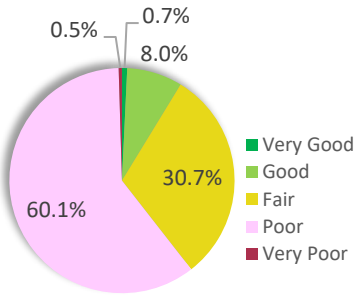



**Figure 9-3.** Condition assessment results for patch shape.

**Table 9-6**. Condition assessment results for patch shape.

| Condition Rating | Area (ha) | Percent of Total |
|---|---|---|
| Very Good | 1.58 | 0.7% |
| Good | 16.87 | 8.0% |
| Fair | 64.93 | 30.7% |
| Poor | 126.98 | 60.1% |
| Very Poor | 0.99 | 0.5% |



## 9.4 Adjacent Permeable Land Use

INDICATOR: The extent of permeable land cover within 120 m of an asset with more permeable adjacent lands resulting in a more favorable rating.

RATIONALE: How and the extent to which a given natural area is influenced by drainage in the adjacent landscape varies depending on factors such as local topography and soils, where the feature "sits" in the landscape (e.g., upland versus lowland) and the size and nature of the feature itself. However, it is well-established that the condition of a terrestrial natural feature tends to be negatively impacted when more of the surrounding land uses are impervious (i.e., paved, concrete or buildings) as this tends to alter pre-existing drainage and infiltration pathways, which can cause a natural area to receive more, or less, drainage than prior to being in the built context. Urban runoff also typically carries a host of sediments and contaminants, and when such runoff is directed to natural areas and not properly treated, it can negatively impact the feature and its functions.

Increases in the extent of impervious surfaces within a given watershed or catchment area are generally known to have negative impacts to natural features in that watershed or catchment area, particularly for features downstream of the impervious areas, resulting in a push towards planning that limits impervious surfaces and incorporates low impact development measures that facilitate local infiltration. However, land cover types with extensive pervious surfaces that are not "natural" *per se* but occur in the lands adjacent to natural areas, such as manicured parks/open spaces and agricultural lands, are recognized as potentially supporting the functions of nearby natural areas in some regards by providing one or more of the following:

- Permeable surfaces (and therefore potentially supporting hydrologic regimes),
- Temporary or permanent vegetation (e.g., isolated or small groupings of trees/landscaped areas, agricultural crops), and/or
- Intervening lands between natural areas and built areas that are used less frequently and/or less intensively by people.

For example, a school ground between a wooded area and a high-density residential area is generally considered preferable to having the high-density residential area directly abutting the natural area.

APPROACH: A 120 m buffer (exclusive of asset area) was drawn around each natural asset. The area of the 120 m buffer was estimated in hectares, and the percentage of each buffer that consists of natural areas/permeable land uses was estimated. A ranking was then applied to each buffer and linked to the relevant natural assets.

SCORING: A ranking was assigned to each asset based on the percentage of complementary land uses within the 120 m buffer as follows:

- Very Good: 51 to 100% permeable land uses
- Good: 31% to 50% permeable land uses
- Fair: 16% to 30% permeable land uses
- Poor: 1% to 15% permeable land uses
- Very Poor: 0% permeable land uses

RESULT: The following figures and table summarize the results of this condition indicator.

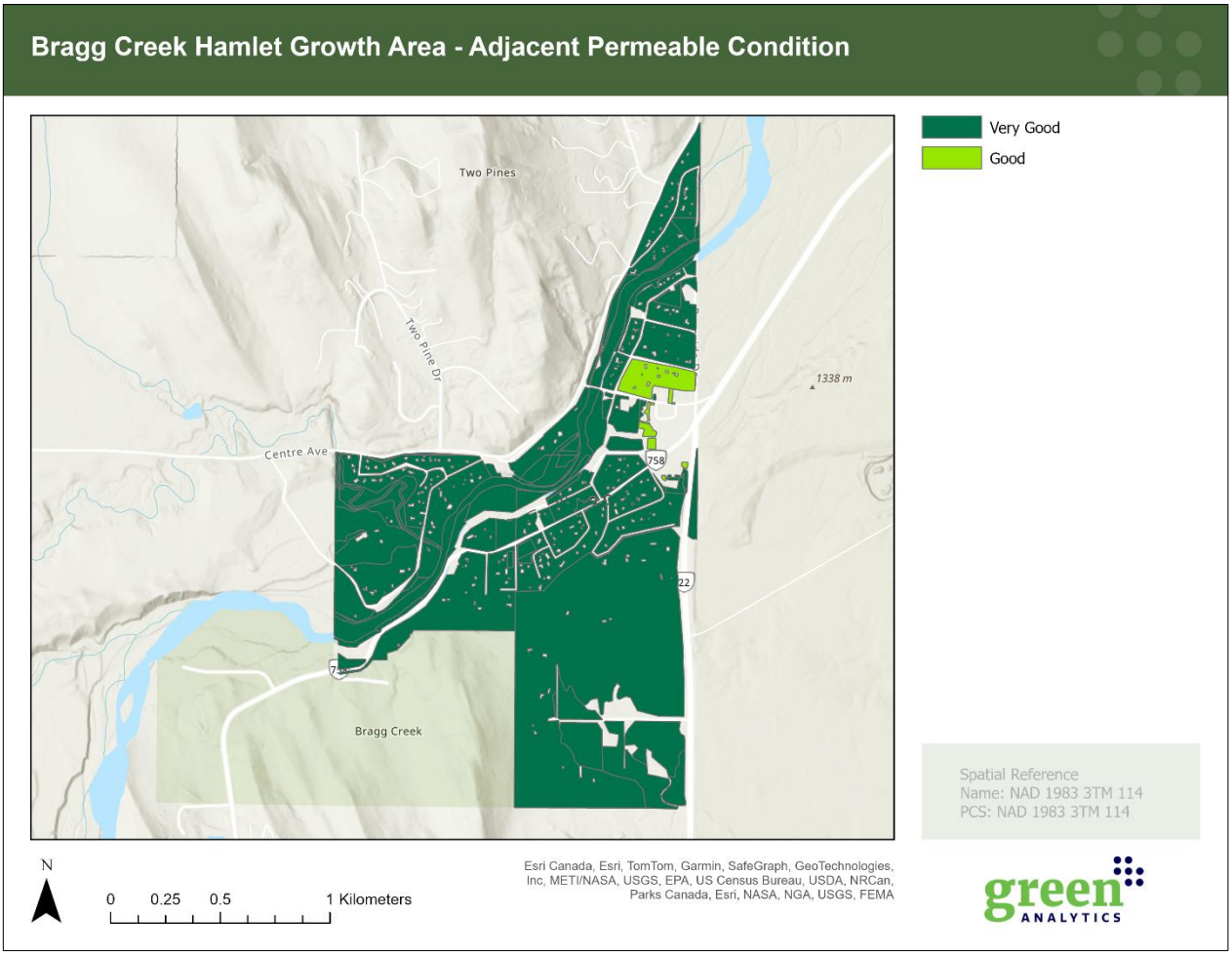
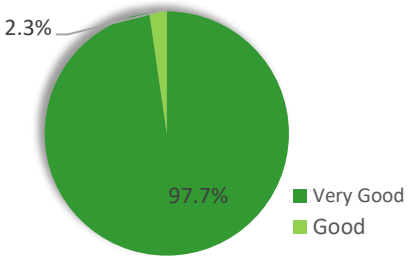



**Figure 9-4.** Condition assessment results for adjacent permeable land use.

**Table 9-7**. Condition assessment results for adjacent permeable land use.

| Condition Rating | Area (ha) | Percent of Total |
|---|---|---|
| Very Good | 206.48 | 97.7% |
| Good | 4.86 | 2.3% |
| Fair | 0 | 0% |
| Poor | 0 | 0% |
| Very Poor | 0 | 0% |



## 9.5 Natural Asset Proximity to Watercourses

INDICATOR: Proximity of each natural asset to the nearest watercourse, with assets located closer to watercourses receiving higher scores for riparian connectivity.

RATIONALE: The ecological value of a natural asset is influenced not only by its intrinsic characteristics but also by its spatial context within the landscape. Proximity to watercourses is a key factor in determining an asset's role in supporting connectivity, biodiversity, and ecosystem function. In the Alberta Foothills, forested areas adjacent to streams—commonly known as riparian forests—serve as disproportionately important habitat corridors. These narrow forest strips support high levels of wildlife activity and species diversity relative to their spatial extent (Andison & McCleary 2002).

Scientific studies have shown that large mammals such as grizzly bears and moose preferentially use riparian corridors for movement and foraging, indicating their functional importance in maintaining landscape connectivity (Phoebus et al. 2017; Dickie et al. 2019). These corridors also facilitate species dispersal, predator-prey dynamics, and access to critical resources like forage and shade. Additionally, amphibian and small mammal populations are closely tied to riparian networks and adjacent wetlands, further underlining the multi-taxa value of proximity to hydrologic features.

This general principle is widely recognized. For example, Environment Canada's (2013) habitat guidelines for southern Ontario recognize the significance of terrestrial habitats that are either adjacent to or intersected by hydrological features within floodplains. The presence of watercourses in close proximity to terrestrial habitats is thus a widely accepted proxy for increased ecological connectivity and functional habitat value.

This approach assumes that proximity to hydrological features increases the likelihood that an asset participates in riparian processes and contributes to landscape-scale ecological connectivity. It captures not only the structural potential for movement corridors (e.g., for mammals and amphibians), but also the likelihood of enhanced ecosystem services such as water regulation, nutrient exchange, and biodiversity support.

APPROACH: To assess this indicator, the Euclidean (straight-line) distance from each natural asset polygon to the nearest mapped watercourse was calculated using GIS analysis. Assets that overlap a watercourse were assigned a distance of zero. A continuous score was then derived, with closer proximity to a watercourse associated with higher values for riparian connectivity.

SCORING: Ratings were allocated as follows:

- Very Good: Asset directly intersects watercourse.
- Good: Asset is within 30 m of a watercourse but does not directly intersect it.
- Fair: Asset is within 30 - 120 m of a watercourse.
- Poor: Asset is within 120 – 240 m of a watercourse.
- Very Poor: Asset is greater than 240 m away from a watercourse.

RESULTS: The following figures and table summarize the results of this condition indicator.

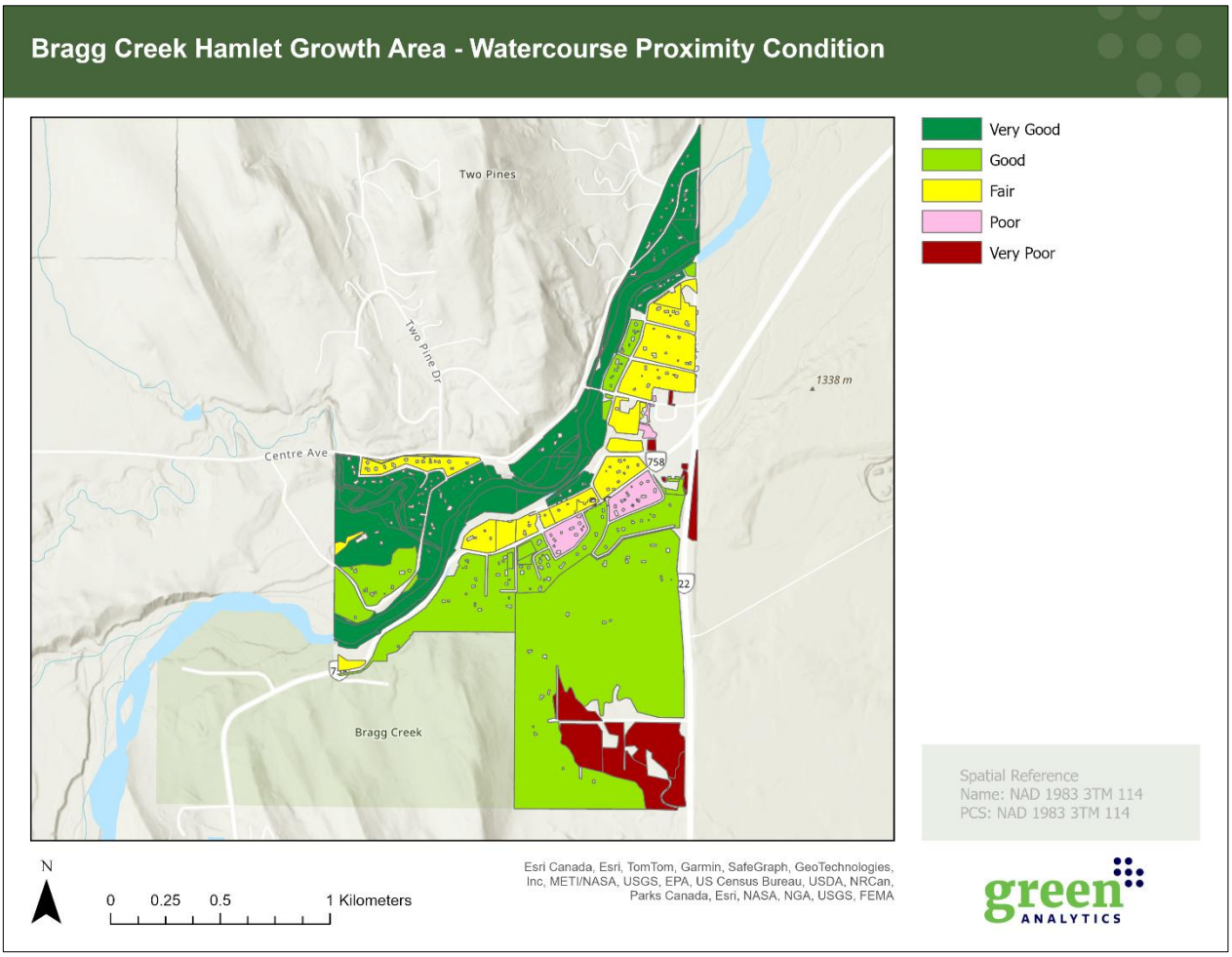
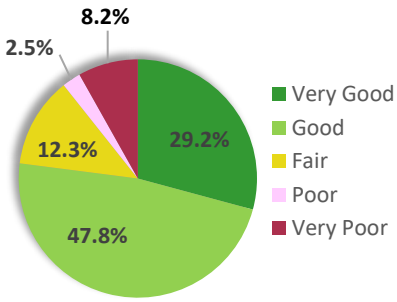



**Figure 9-5.** Condition assessment results for natural asset proximity to watercourse.

**Table 9-8**. Condition assessment results for natural asset proximity to watercourse.

| Condition Rating | Area (ha) | Percent of Total |
|---|---|---|
| Very Good | 61.71 | 29.2% |
| Good | 101.10 | 47.8% |
| Fair | 25.95 | 12.3% |
| Poor | 5.36 | 2.5% |
| Very Poor | 17.23 | 8.2% |



## 9.6 Forest Proximity to Other Natural Assets

INDICATOR: A measure of the proximity of forest assets to other natural asset classes with assets in closer proximity rating higher than those further away.

RATIONALE: Measuring proximity is a common metric used for understanding and improving habitat connectivity, particularly in fragmented landscapes. It helps identify critical areas for wildlife movement and gene flow, supporting biodiversity and ecosystem resilience by facilitating species dispersal and recolonization. According to research by Environment Canada (2013):

- For forest birds, research has found that habitats near other natural areas support more species than isolated habitats of the same size, and that some species with large home ranges may use several patches instead of one large area.
- In landscapes with relatively low forest cover overall, species diversity and survivorship increase when the remaining habitat patches are larger and more clumped or aggregated.
- Based on the limited available science, the isolation between forest patches for forest birds generally occurs at about five kilometres, but for amphibians at between one and two kilometres. For forest plants, some level of immediate proximity is required.

In urban and urbanizing contexts, proximity measures guide the creation of interconnected green spaces that enhance ecological functions, such as air quality and urban cooling. These metrics also inform conservation strategies, policy-making, and land-use planning decisions, ensuring that both ecological and human needs are met.

APPROACH: Each forest asset patch was buffered by the condition rating thresholds noted below and the appropriate rating was applied based on the closest buffer where another natural asset class patch was found.

SCORING: Based on the research noted by Environment Canada (2013) and the associated proximities, condition ratings were assigned as follows:

- Very good: Level 2 forest assets < 1 km from any other Level 2 forest asset
- Good: Level 2 forest assets within 1 to 2 km of any other Level 2 forest asset
- Fair: Level 2 forest assets within 2 to 3 km of any other Level 2 forest asset
- Poor: Level 2 forest assets within 3 to 5 km of any other Level 2 forest asset
- Very poor: Level 2 forest are > 5 km from any other Level 2 forest asset

RESULTS: The following figures and table summarize the results of this condition indicator.

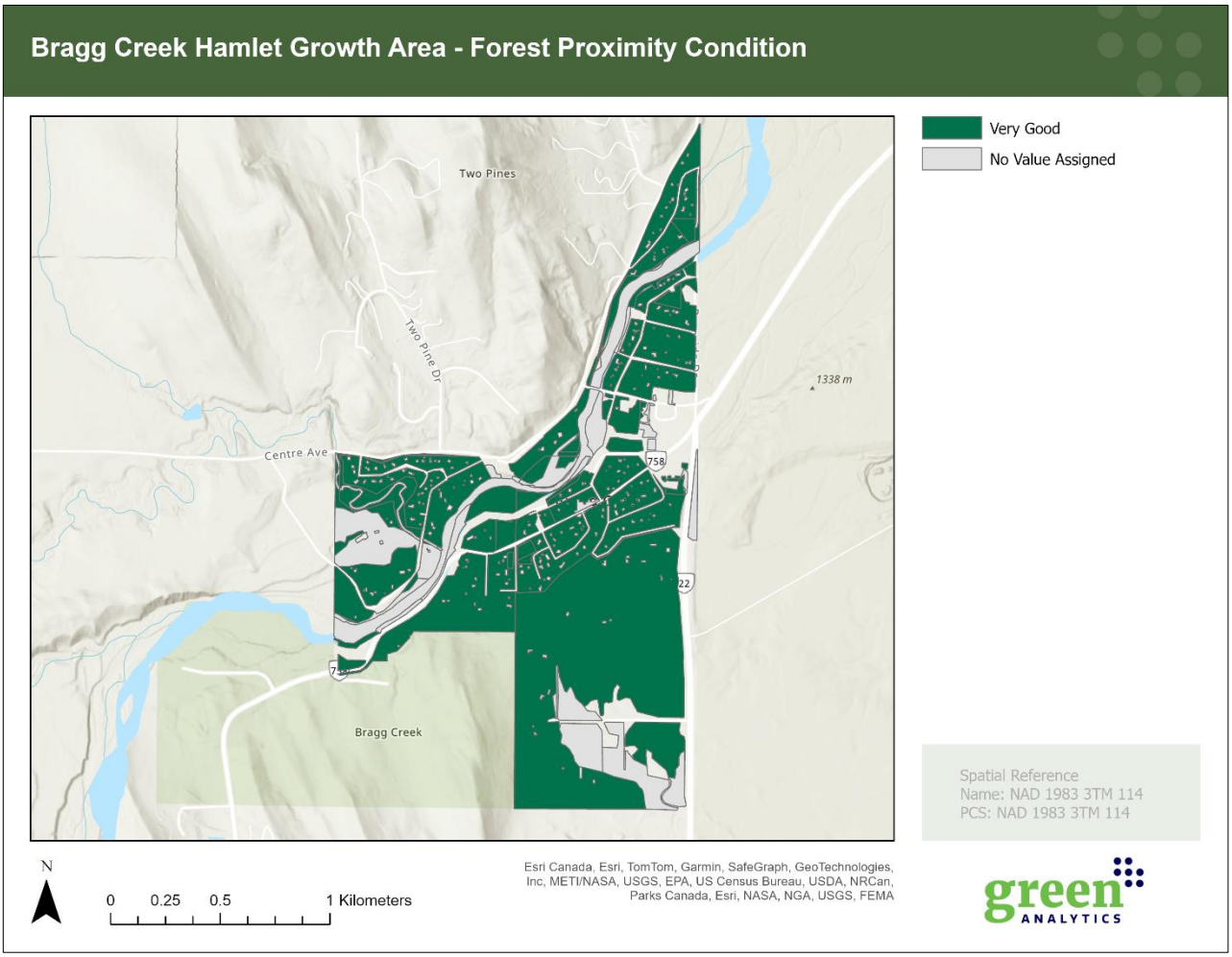
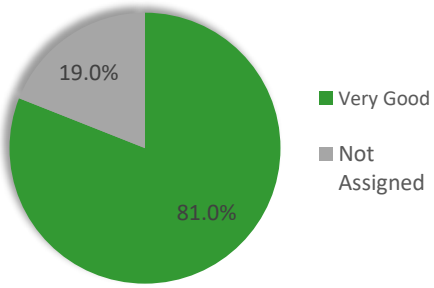



**Figure 9-6**. Condition assessment results for forest proximity to other natural assets.

**Table 9-9**. Condition assessment results for forest proximity to other natural assets .

| Condition Rating | Area (ha) | Percent of Total |
|---|---|---|
| Very Good | 171.19 | 81.0% |
| Good | 0 | 0% |
| Fair | 0 | 0% |
| Poor | 0 | 0% |
| Very Poor | 0 | 0% |
| Not Risk Assigned | 40.15 | 19.0% |



## 9.7 Open Water Riparian

INDICATOR: Proportion of riparian zone of open water assets that is covered by continuous riparian vegetation (trees and shrubs). Higher cover indicates better ecological condition.

RATIONALE: Natural riparian vegetation plays a critical role in maintaining ecological health along open water bodies. Dense, continuous natural cover stabilizes banks, filters pollutants, shades aquatic habitats, and supports biodiversity. In contrast, fragmentation is often associated with degraded conditions, erosion risk, and reduced ecological function. Riparian zones with low natural cover often indicate anthropogenic modification such as mowing, clearing, riprapping, or development encroachment. The intent of this indicator is to reflect riparian health as a proxy for water quality, habitat quality, and resilience of freshwater systems.

APPROACH: This indicator assesses the percent of the riparian buffer zone adjacent to open water that is covered by natural vegetation. The following thresholds adapted from the literature and expert judgment, condition scores were assigned based on the continuity and extent of woody cover.

SCORING: Percent cover of woody vegetation along riparian edge (within 30 m of open water):

- Very Good: >75% of riparian zone length covered by continuous dense natural vegetation
- Good: 50–75% covered, with relatively continuous patches of trees/shrubs
- Fair: 35–49% covered, with scattered or patchy woody vegetation
- Poor: 25–34% covered, primarily herbaceous with occasional shrubs or isolated trees
- Very Poor: <25% covered, riparian zone dominated by herbaceous species, lawn, or riprap; woody vegetation largely absent

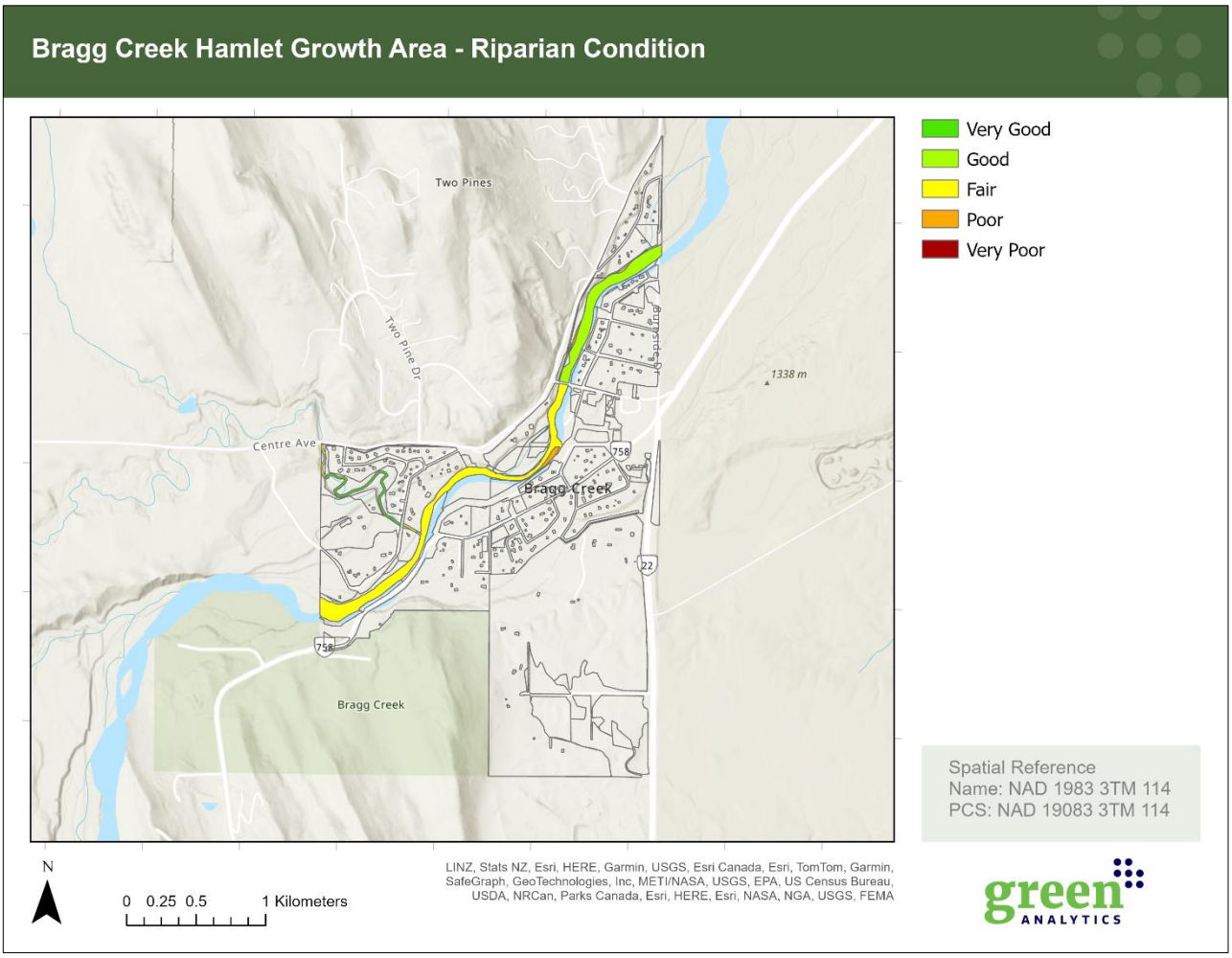
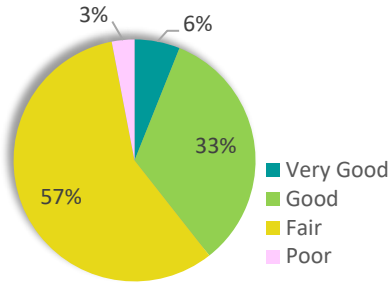



**Figure 9-7**. Condition assessment results for open water riparian.

**Table 9-10.** Condition assessment results for open water riparian.

| Condition Rating | Area (ha) | Percent of Total |
|---|---|---|
| Very Good | 0.82 | 6% |
| Good | 4.21 | 33% |
| Fair | 7.33 | 57% |
| Poor | 0.40 | 3% |
| Very Poor | 0 | 0% |
| Not Assigned | 198.59 | |



# 10 Appendix C: Risk Profiling Workshop Participants

**Green Analytics**

**Amy Taylor**
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Founder, Bragg Creek Wild

**Dave Klepacki**
Executive Director, Bragg Creek Environmental Coalition

# 11 Appendix D: Ecosystem Services Valuation Methods & Detailed Results

Ecosystem service valuation recognizes the economic contribution of natural assets and supports informed decision-making in land use planning and conservation. This appendix provides an overview of the approach employed to establish the value of services provided by the natural assets within the Bragg Creek Hamlet Growth Area, which relied on benefit transfer.

## 11.1 Overview of Benefit Transfer Approach

To value services provided by the natural assets within the Bragg Creek Hamlet Growth Area, a benefit transfer approach was employed. Benefit transfer entails taking economic values from existing studies and applying them to a policy site with similar traits to the location of the study site (UNEP 2013). Benefit transfer is a widely applied economic valuation tool to value ecosystem services at policy sites when primary data collection is not feasible due to time and cost restraints. It is a way to use economic value estimates derived from one or more existing study sites[3] and apply them to similar policy sites[4], making it a cost-effective alternative for conducting valuation studies (Plummer 2009; Brander 2013; Navrud 2000; Grammatikopoulou et al., 2023).

Benefit transfer for ecosystem service valuation involves the steps identified in Figure 11-1 (Brander 2013). The first step is to define the policy site. This step requires the identification of relevant land cover types (Section 3 of this report) and corresponding ecosystem services (Section 6 of this report). The next step is to select existing data by identifying valuation studies and databases that contain dependable and pertinent valuation information (Brander 2013). The select studies should be relevant to the policy site (in this case, Bragg Creek Hamlet Growth Area). After appropriate studies have been selected, the next step is to transfer the values from the study site to the policy site. In some cases, adjustments take place through the transfer process, such as adjusting to Canadian dollars or for inflation.

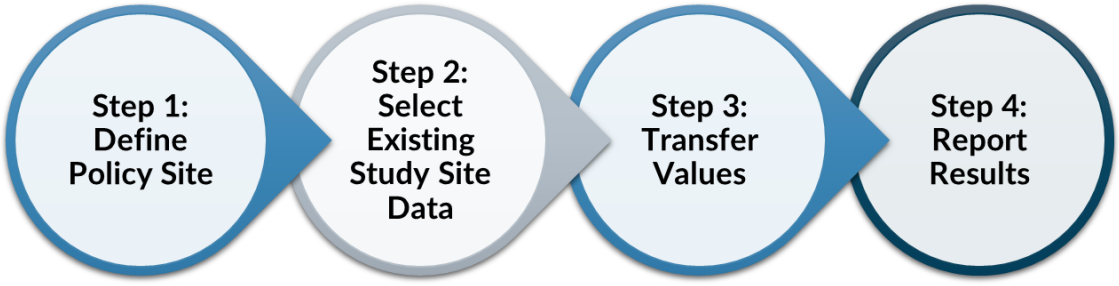


**Figure 11-1**. Steps for conducting benefit transfer.

Benefit transfer has been applied to ecosystem service valuations for wetlands, forests, and waterbodies to allow policymakers to make informed decisions with limited resources and constrained information (Olar et

[3] *Study site* in the context of value transfer (benefit transfer) usually refers to the location where the primary economic valuation study was conducted (Brander 2013).

[4] *Policy site* in the context of value transfer (benefit transfer) usually refers to the location where the transfer value estimate will be applied (Brander 2013).

al., 2013; He et al., 2015). Benefit transfer is particularly appealing as it is a cost-effective and timely alternative to primary valuation studies that involve detailed surveys (Boyle and Parmeter 2017; Grammatikopoulou et al., 2023). The key limitation of benefit transfer approaches is the degree of uncertainty associated with the valuation estimate for the policy site; the accuracy of the final value estimate depends on how applicable the study site is to the policy site (Boutwell and Westra 2013). For this reason, the results presented in this document should be interpreted as approximate order of magnitude estimates for the ecosystem services values being generated.

## 11.2 Benefits Transfer for Bragg Creek Hamlet Growth Area

Ecosystem service values were transferred to the natural assets within the Bragg Creek Hamlet Growth Area through the following steps:

1. **Review of existing literature and valuation databases to develop a list of valuation studies (the "valuation database")**:
    a. Green Analytics maintains an Ecosystem Service Valuation Database of primary valuation estimates relevant to the Canadian context. This database served as a foundational source for identifying relevant studies and transfer values.
    b. Additional research focused on Canadian and U.S.-based studies to ensure geographic and policy relevance.
    c. Recurring themes between the studies were identified including the common factors that influence ecosystem service values (e.g., land cover type) as well as service definitions.
    d. A total of 96 valuation studies were identified.
2. **Defined "inclusion criteria" to select value estimates for transfer to the Bragg Creek Hamlet Growth Area:**
    a. Urban-focused studies were excluded to ensure the values aligned with the ecological and socio-economic context of the more rural nature of Bragg Creek Hamlet Growth Area.
    b. Studies focused on coastal and marine ecosystems were removed, as they do not apply to the region's inland landscape.
    c. Preference was given to more recent studies, although older research was retained if suitable.
    d. Studies were further filtered to retain only those containing the target ecosystem services.
3. **Refined the valuation database (i.e., filter out some studies) based on the inclusion criteria**:
    a. After excluding less relevant studies, 15 unique studies were identified (see Table 11-1 for details).
    b. Values for natural assets present within the Bragg Creek Hamlet Growth Area were derived by averaging estimates from relevant studies identified in the valuation database. This included values for forest, grassland and open water assets. Sparsely vegetated assets (which are comprised of a combination of grasslands and trees) were assigned the same value as grasslands. Enhanced assets (i.e. manicured greenspaces) were excluded from the valuation.
4. **Adjusted the values for consistency (e.g., adjust for inflation, convert to CAD in the case of relevant international studies)**.

Note that the benefit transfer approach described above was employed to value all services for the Bragg Creek Hamlet Growth Area with the exception of carbon sequestration. The approach to valuing carbon sequestration is described below

**Table 11-1**. Selected ecosystem service values by land cover type from literature.

| Ecosystem Service | Country | Location | Valuation Technique | 2023 CAD Value | Reference |
|---|---|---|---|---|---|
| **Land Cover Type: Forest** | | | | | |
| Aesthetics | Canada | Region of Halton | Area-based benefit transfer | $1,143.96 | Deloyde and Mabee (2023) |
| Air quality | Canada | Region of Halton | Area-based benefit transfer | $647.31 | Deloyde and Mabee (2023) |
| Air quality | Canada | Montreal Metropolitan Region | Area-based benefit transfer | $876.52 | Dupras and Alam (2015) |
| Erosion control | Canada | Region of Halton | Area-based benefit transfer | $792.77 | Deloyde and Mabee (2023) |
| Water Regulation and Flood control | Canada | Region of Halton | Area-based benefit transfer | $536.13 | Deloyde and Mabee (2023) |
| Water Regulation and Flood control | Canada | Region of Halton | Area-based benefit transfer | $1,479.57 | Deloyde and Mabee (2023) |
| Water purification and waste treatment | Canada | Region of Halton | Area-based benefit transfer | $539.25 | Deloyde and Mabee (2023) |
| Water purification and waste treatment | Canada | Montreal Metropolitan Region | Area-based benefit transfer | $179.35 | Dupras and Alam (2015) |
| Habitat Provision | Canada | Montreal Metropolitan Region | Area-based benefit transfer | $1,192.07 | Dupras and Alam (2015) |
| Habitat Provision | USA | Colorado | Contingent valuation | $8,884.59 | Loomis and Ekstrand (1998) |
| Habitat Provision | Canada | South Thompson River | Production function | $2.79 | Knowler et al. (2003) |
| Habitat Provision | USA | Pacific Northwest | Choice experiment | $0.06 | Roesch-McNally and Rabotyagov (2016) |
| Habitat Provision | USA | Pacific Northwest | Choice experiment | $3.15 | Roesch-McNally and Rabotyagov (2016) |
| Habitat Provision | USA | Pacific Northwest | Choice experiment | $0.09 | Roesch-McNally and Rabotyagov (2016) |
| Habitat Provision | USA | Pacific Northwest | Choice experiment | $8.45 | Roesch-McNally and Rabotyagov (2016) |
| Habitat Provision | USA | Colorado | Contingent valuation | $155.87 | Walsh et al. (1984) |
| Habitat Provision | Canada | Boreal forest region in Alberta | Actual expenditure | $1.86 | Hauer and Boutin (2018) |
| Habitat Provision | Canada | Boreal forest region in Alberta | Actual expenditure | $4.85 | Hauer and Boutin (2018) |
| Habitat Provision | Canada | Woodland Caribou ranging area | WTP; Compensating variation | $25.79 | Harper (2012) |
| Habitat Provision | Canada | Woodland Caribou ranging area | WTP; Compensating variation | $37.58 | Harper (2012) |
| Habitat Provision | Canada | Alberta fish and wildlife habitat | Contingent valuation | $1,438.46 | Macnab and Brusnyk (1993) |
| Habitat Provision | Canada | Alberta fish and wildlife habitat | Contingent valuation | $1,390.73 | Macnab and Brusnyk (1993) |
| Habitat Provision | Canada | Alberta fish and wildlife habitat | Contingent valuation | $2,157.71 | Macnab and Brusnyk (1993) |
| Habitat Provision | Canada | Alberta fish and wildlife habitat | Contingent valuation | $1,607.24 | Macnab and Brusnyk (1993) |
| Habitat Provision | Canada | Alberta fish and wildlife habitat | Contingent valuation | $2,876.92 | Macnab and Brusnyk (1993) |
| Habitat Provision | Canada | Alberta fish and wildlife habitat | Contingent valuation | $1,827.93 | Macnab and Brusnyk (1993) |
| Habitat Provision | Canada | Alberta fish and wildlife habitat | Contingent valuation | $3,596.17 | Macnab and Brusnyk (1993) |
| Habitat Provision | Canada | Alberta fish and wildlife habitat | Contingent valuation | $2,046.55 | Macnab and Brusnyk (1993) |
| Habitat Provision | Canada | Northwestern Saskatchewan | CVM - open-ended | $5.88 | Tanguay et al. (1995) |
| Habitat Provision | Canada | Northwestern Saskatchewan | CVM - dichotomous choice | $14.16 | Tanguay et al. (1995) |
| Habitat Provision | Canada | Northwestern Saskatchewan | CVM - dichotomous choice | $17.16 | Tanguay et al. (1995) |
| Nutrient cycling | Canada | Region of Halton | Area-based benefit transfer | $717.96 | Deloyde and Mabee (2023) |

| Ecosystem Service | Country | Location | Valuation Technique | 2023 CAD Value | Reference |
|---|---|---|---|---|---|
| Soil Formation | Canada | Region of Halton | Area-based benefit transfer | $24.94 | Deloyde and Mabee (2023) |
| **Land Cover Type: Grassland / Sparsely Vegetated** | | | | | |
| Aesthetics | Canada | Region of Halton | Area-based benefit transfer | $1,798.55 | Deloyde and Mabee (2023) |
| Aesthetics | Canada | Montreal Metropolitan Region | Area-based benefit transfer | $210.37 | Dupras and Alam (2015) |
| Air quality | Canada | Region of Halton | Area-based benefit transfer | $720.04 | Deloyde and Mabee (2023) |
| Air quality | Canada | Region of Halton | Area-based benefit transfer | $22.86 | Deloyde and Mabee (2023) |
| Air quality | USA | Various states | Damage cost | $1.65 | Gopalakrishnan et al. (2018) |
| Air quality | USA | Various states | Damage cost | $0.91 | Gopalakrishnan et al. (2018) |
| Air quality | USA | Various states | Damage cost | $0.01 | Gopalakrishnan et al. (2018) |
| Air quality | USA | Various states | Damage cost | $0.03 | Gopalakrishnan et al. (2018) |
| Erosion control | Canada | Region of Halton | Area-based benefit transfer | $28.05 | Deloyde and Mabee (2023) |
| Erosion control | Canada | Region of Halton | Area-based benefit transfer | $6.23 | Deloyde and Mabee (2023) |
| Erosion control | Canada | Montreal Metropolitan Region | Area-based benefit transfer | $47.20 | Dupras and Alam (2015) |
| Erosion control | Canada | Thames River Basin | Avoided cost | $75.53 | Fox and Dickson (1990) |
| Erosion control | USA | Various states | Replacement cost | $90.15 | Pimentel et al. (1995) |
| Erosion control | USA | Various states | Replacement cost | $239.70 | Pimentel et al. (1995) |
| Water Regulation and Flood control | Canada | Region of Halton | Area-based benefit transfer | $10.39 | Deloyde and Mabee (2023) |
| Water purification and waste treatment | Canada | Region of Halton | Area-based benefit transfer | $35.33 | Deloyde and Mabee (2023) |
| Habitat Provision | Canada | Montreal Metropolitan Region | Area-based benefit transfer | $3,048.95 | Dupras and Alam (2015) |
| Nutrient cycling | Canada | Region of Halton | Area-based benefit transfer | $35.33 | Deloyde and Mabee (2023) |
| Nutrient cycling | USA | Various states | Replacement cost | $182.09 | Pimentel et al. (1995) |
| Soil Formation | Canada | Region of Halton | Area-based benefit transfer | $14.55 | Deloyde and Mabee (2023) |
| Soil Formation | Canada | Region of Halton | Area-based benefit transfer | $8.31 | Deloyde and Mabee (2023) |
| **Land Cover Type: Open Water** | | | | | |
| Aesthetics | Canada | Region of Halton | Area-based benefit transfer | $935.12 | Deloyde and Mabee (2023) |
| Water Regulation and Flood control | Canada | Region of Halton | Area-based benefit transfer | $2,305.59 | Deloyde and Mabee (2023) |
| Water purification and waste treatment | Canada | Region of Halton | Area-based benefit transfer | $21,059.92 | Deloyde and Mabee (2023) |
| Water purification and waste treatment | Canada | Montreal Metropolitan Region | Contingent ranking | $59.56 | Poder (2015) |
| Water purification and waste treatment | Canada | South Tobacco Creek | CVM | $2,250.71 | Mingle (2017) |
| Water purification and waste treatment | Canada | South Tobacco Creek | CVM | $2,674.54 | Mingle (2017) |
| Water purification and waste treatment | Canada | South Tobacco Creek | CVM | $1,776.76 | Mingle (2017) |
| Water purification and waste treatment | Canada | South Tobacco Creek | CVM | $2,063.48 | Mingle (2017) |
| Nutrient cycling | Canada | Montreal Metropolitan Region | Contingent ranking | $12.41 | Poder (2015) |
| Nutrient cycling | Canada | Region of Halton | Area-based benefit transfer | $858.23 | Deloyde and Mabee (2023) |

## 11.3 Valuing Carbon Sequestration

To value carbon sequestration for the Bragg Creek Hamlet Growth Area natural assets, the project team first established sequestration rates for each relevant asset type. Sequestration rates for forest and grassland assets were identified through a comprehensive literature review. Table 11-2 displays the carbon sequestration rates that were used for the natural assets within the Bragg Creek Hamlet Growth Area. It also shows the respective areas by asset type that the rates were applied to and the total sequestration from the assets on an annual basis. Note that the rate for grasslands was also applied to sparse vegetation assets. The detailed carbon sequestration rates by land cover class, as obtained from the literature, are presented in Table 11-3.

**Table 11-2.** Sequestration rates applied to forest, grassland and sparse vegetation assets in the Bragg Creek Hamlet Growth Area.

| Asset Type | Rate (t C $ha^{-1}$ $year^{-1}$) | Area (ha) | Annual Total (t C $year^{-1}$) | Equivalent Total (t CO2e $year^{-1}$) |
|---|---|---|---|---|
| Forests | 1.14 | 171.52 | 195.53 | 717.60 |
| Grasslands | 0.48 | 7.16 | 3.43 | 12.59 |
| Sparse Vegetation | 0.48 | 1.88 | 0.90 | 3.30 |

Note: Average of sequestration rate for forest (t c ha-1 year -1) and grassland/sparse vegetation(t c $ha^{-1}$ $year^{-1}$), details in Table 11-3

The estimated annual carbon sequestration for each asset type within the Hamlet Growth Area, shown in the second last column in Table 11-2, is calculated by multiplying the sequestration rate by the total area for each asset type. These annual totals reflect the carbon sequestration potential of each asset type under current land cover conditions, providing a quantitative basis for assessing climate regulation benefits. Since every atom of carbon sequestered by a natural asset means 1 molecule of $CO_2e$ has been removed from the atmosphere, tonnes of carbon sequestered can be converted to the corresponding tonnes of $CO_2e$ removed. This is done using a standard conversion factor where 1 tonne of carbon corresponds to approximately 3.67 tonnes of $CO_2e$.

Once the sequestration rates for the natural assets were defined, these were valued by applying the Canadian Social Cost of Carbon (SCC) to the total sequestration for each asset type. The SCC measures economic damages from one metric tonne of $CO_2$ emissions by accounting for reduced agricultural productivity together with human health effects and additional flood risks as well as energy system disruptions and ecosystem service losses (Government of Canada 2023). The SCC is regularly used by the federal government in cost–benefit analyses of regulations, infrastructure investments, and land use planning decisions (Government of Canada, 2023). The application of the SCC provides Bragg Creek with a standardized framework for evaluating natural assets' role in achieving Canada's climate change mitigation targets. The SCC for 2025 is $271 per $tCO_2e$ (tonnes carbon dioxide equivalent) in 2021 Canadian dollars. This adjusts to $301.43 in 2023 CAD based on inflation (Government of Canada 2023).

**Table 11-3.** Carbon sequestration rates for different natural asset classes from the literature.

| Land Cover Type | Species Type | Tonnes C / ha / yr | Reference |
|---|---|---|---|
| Forest | Regional forest | 2.12 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.85 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.54 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.27 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.20 | Sun J. et. al. (2016) |
| Forest | Regional forest | 1.10 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.07 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.00 | Lu X. et. al. (2015) |

| Land Cover Type | Species Type | Tonnes C / ha / yr | Reference |
|---|---|---|---|
| Forest | Regional forest | 0.77 | Lu X. et. al. (2015) |
| Forest | Regional forest | 0.60 | Sun J. et. al. (2016) |
| Forest | Regional forest | 0.60 | Lu X. et. al. (2015) |
| Forest | Regional forest | 0.52 | Lu X. et. al. (2015) |
| Forest | Woodland | 0.40 | Bruce, J. P. et al. (1999) |
| Forest | Regional forest | 2.12 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.85 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.54 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.27 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.20 | Sun J. et. al. (2016) |
| Forest | Regional forest | 1.10 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.07 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.00 | Lu X. et. al. (2015) |
| Forest | Regional forest | 0.77 | Lu X. et. al. (2015) |
| Forest | Regional forest | 0.60 | Sun J. et. al. (2016). |
| Forest | Regional forest | 0.60 | Lu X. et. al. (2015) |
| Forest | Regional forest | 0.52 | Lu X. et. al. (2015) |
| Forest | Woodland | 0.40 | Bruce, J. P. et al. (1999) |
| Forest | Regional forest | 2.12 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.85 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.54 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.27 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.20 | Sun J. et. al. (2016) |
| Forest | Regional forest | 1.10 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.07 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.00 | Lu X. et. al. (2015) |
| Forest | Regional forest | 0.77 | Lu X. et. al. (2015) |
| Forest | Regional forest | 0.60 | Sun J. et. al. (2016) |
| Forest | Regional forest | 0.60 | Lu X. et. al. (2015) |
| Forest | Regional forest | 0.52 | Lu X. et. al. (2015) |
| Forest | Afforestation (Luvisol soil) | 0.11 | Foote R. L. and Grogan P. (2009) |
| Forest | Afforestation (Brunisol soil) | 0.10 | Foote R. L. and Grogan P. (2009) |
| Forest | Afforestation (Podzol soil) | 0.09 | Foote R. L. and Grogan P. (2009) |
| Forest | Urban forest | 2.59 | Every Tree Counts (2013) |
| Forest | Urban forest | 2.03 | Every Tree Counts (2013) |
| Forest | Norway spruce | 1.81 | Wotherspoon A. et. al. (2013) |
| Forest | White cedar | 1.36 | Wotherspoon A. et. al. (2013) |
| Forest | Woodland | 0.40 | Bruce, J. P. et al. (1999) |
| Forest | Regional forest | 2.12 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.85 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.54 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.27 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.20 | Sun J. et. al. (2016) |
| Forest | Regional forest | 1.10 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.07 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.00 | Lu X. et. al. (2015) |
| Forest | Regional forest | 0.77 | Lu X. et. al. (2015) |
| Forest | Regional forest | 0.60 | Sun J. et. al. (2016). |
| Forest | Regional forest | 0.60 | Lu X. et. al. (2015) |
| Forest | Regional forest | 0.52 | Lu X. et. al. (2015) |
| Forest | Afforestation (Luvisol soil) | 0.11 | Foote R. L. and Grogan P. (2009) |
| Forest | Afforestation (Brunisol soil) | 0.10 | Foote R. L. and Grogan P. (2009) |
| Forest | Afforestation (Podzol soil) | 0.09 | Foote R. L. and Grogan P. (2009) |
| Forest | Hybrid poplar | 3.21 | Winans, K. S et al. (2015) |
| Forest | Urban forest | 2.59 | Every Tree Counts (2013) |

| Land Cover Type | Species Type | Tonnes C / ha / yr | Reference |
|---|---|---|---|
| Forest | Hybrid popular | 2.12 | Wotherspoon et. al. (2013) |
| Forest | Urban forest | 2.03 | Every Tree Counts (2013) |
| Forest | Hybrid poplar | 1.90 | Winans et a;. (2015) |
| Forest | Hybrid poplar (silvipasture) | 1.70 | Thevathasan & Gordon (2004) |
| Forest | Hybrid poplar | 1.65 | Thevathasan & Gordon (2004) |
| Forest | Red oak | 1.58 | Wotherspoon et. al. (2013) |
| Forest | Black walnut | 0.84 | Wotherspoon et. al. (2013) |
| Forest | Woodland | 0.40 | Bruce, J. P. et al. (1999) |
| Forest | Regional forest | 2.12 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.85 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.54 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.27 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.20 | Sun J. et. al. (2016) |
| Forest | Regional forest | 1.10 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.07 | Lu X. et. al. (2015) |
| Forest | Regional forest | 1.00 | Lu X. et. al. (2015) |
| Forest | Regional forest | 0.77 | Lu X. et. al. (2015) |
| Forest | Regional forest | 0.60 | Sun J. et. al. (2016) |
| Forest | Regional forest | 0.60 | Lu X. et. al. (2015) |
| Forest | Regional forest | 0.52 | Lu X. et. al. (2015) |
| Forest | Afforestation (Luvisol soil) | 0.11 | Foote R. L. and Grogan P. (2009) |
| Forest | Afforestation (Brunisol soil) | 0.10 | Foote R. L. and Grogan P. (2009) |
| Forest | Afforestation (Podzol soil) | 0.09 | Foote R. L. and Grogan P. (2009) |
| Forest | Urban forest | 2.59 | Every Tree Counts (2013) |
| Forest | Urban forest | 2.03 | Every Tree Counts (2013) |
| Forest | Forest | 1.46 | Akala, V. A., & Lal, R. (2000) |
| Forest | Woodland | 0.40 | Bruce, J. P. et al. (1999) |
| Grassland | Grassland | 0.10 | Sun J. et. al.(2016) |
| Grassland | Established | 0.80 | Bruce, J. P et al. (1991) |
| Grassland | Recently established | 0.60 | Bruce, J. P et al. (1991) |
| Grassland | - | 0.50 | Smith et al. (2001) |
| Grassland | - | 0.40 | Sala & Paruelo (1997) |

## 11.4 Valuation Results by Ecosystem Service

This section presents the results of ecosystem service valuation.

### 11.4.1 Value of Aesthetics

Figure 11-2 shows the per ha values that were applied to the natural assets within the Bragg Creek Hamlet Growth Area: forests were valued at $1,144 per ha; grasslands and sparse vegetation at $1,004 per ha and open water at $935 per ha.

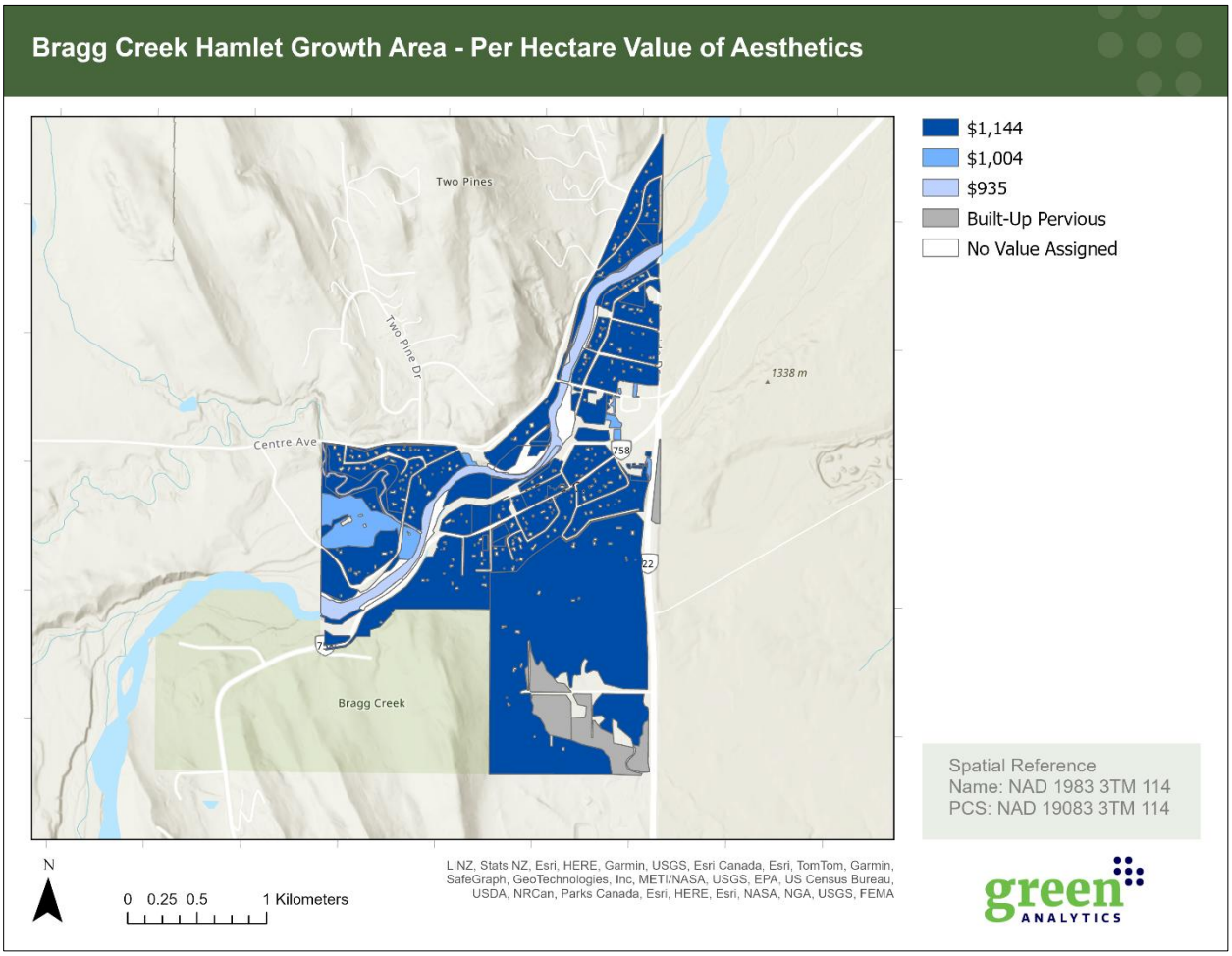


**Figure 11-2**. Bragg Creek Hamlet Growth Area per hectare values for aesthetics.

The value of aesthetic appreciation, which totals $217,220 or $0.22 million annually, is illustrated in Table 11-4. Forest assets, which cover the vast majority of the Growth Area boundary, contribute over 90% of the total value at $196,218.

**Table 11-4**. Annual value of aesthetics for Bragg Creek Hamlet Growth Area by natural asset type.

| Asset Type | Annual Value of Aesthetics | Percent |
|---|---|---|
| Forest | $196,218 | 90.33% |
| Grassland | $7,187 | 3.31% |
| Open Water | $11,928 | 5.49% |
| Sparsely Vegetated | $1,886 | 0.87% |
| Total | $217,220 | |
| Total, in millions | $0.22 | |

## 11.4.2 Value of Air Quality Regulation

Figure 11-3 demonstrates the per ha values that were assigned to the Bragg Creek Hamlet Growth Area natural assets for air quality regulation. The forest assets were assigned a value of $762 per ha, and grasslands and sparsely vegetated assets were valued at $124 per ha.

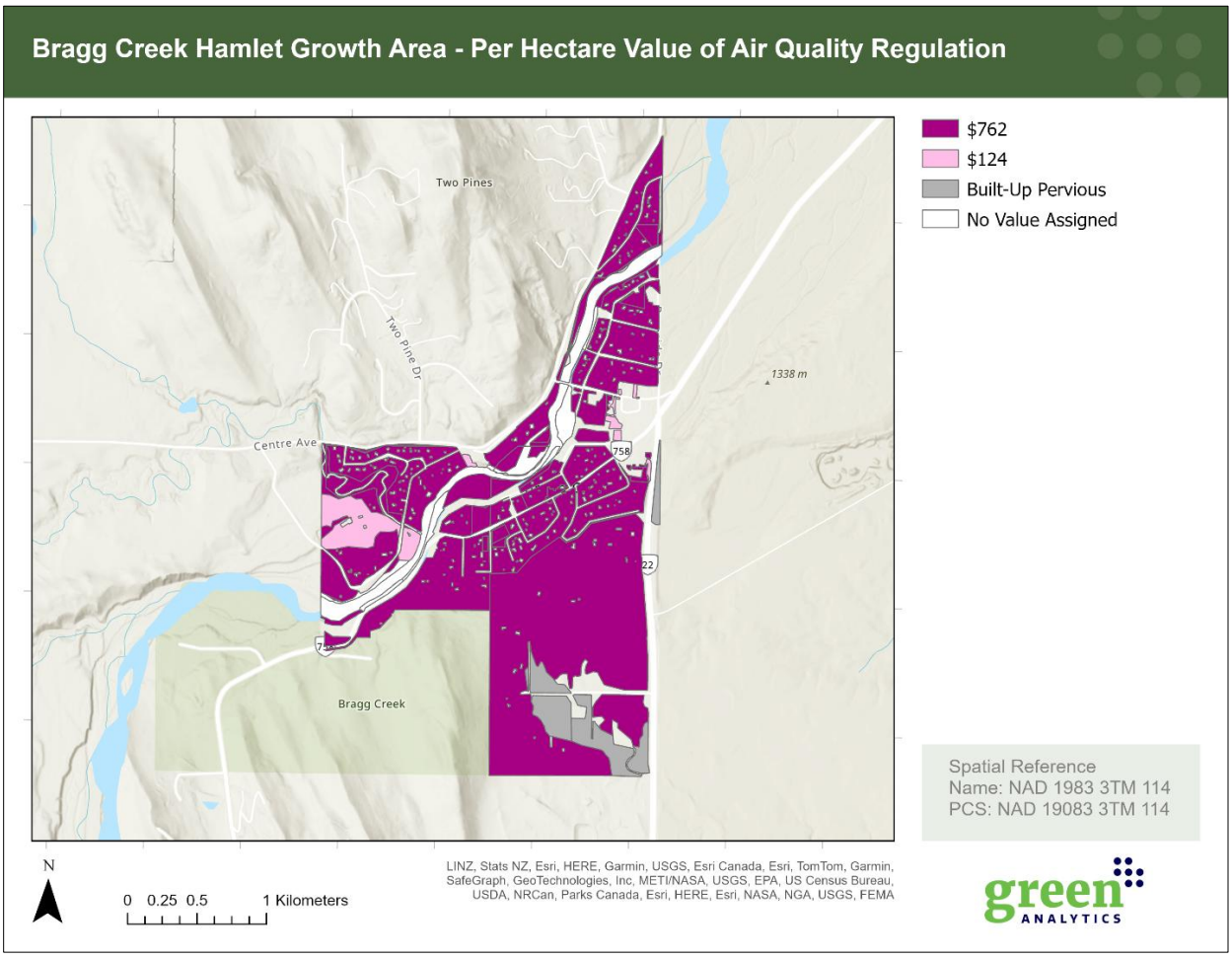


**Figure 11-3**. Bragg Creek Hamlet Growth Area per hectare values for air quality regulation.

Total values for air quality regulation by asset type are demonstrated in Table 11-5. The total value of air quality regulation of $131,810, or $0.13 million, is largely driven by the value provided by forest assets, which is $130,688 annually.

**Table 11-5.** Annual value of air quality regulation for Bragg Creek Hamlet Growth Area by natural asset type.

| Asset Type | Annual Value of Air Quality Regulation | Percent |
|---|---|---|
| Forest | $130,688 | 99.15% |
| Grassland | $889 | 0.67% |
| Open Water | - | - |
| Sparsely Vegetated | $233 | 0.18% |
| Total | $131,810 | |
| Total, in millions | $0.13 | |

## 11.4.3 Value of Carbon Sequestration

The per ha values for carbon sequestration are shown in Figure 11-4. As per the figure, forest assets are valued at $1,260 for each ha and grasslands and sparsely vegetated assets are valued at $531 per ha.

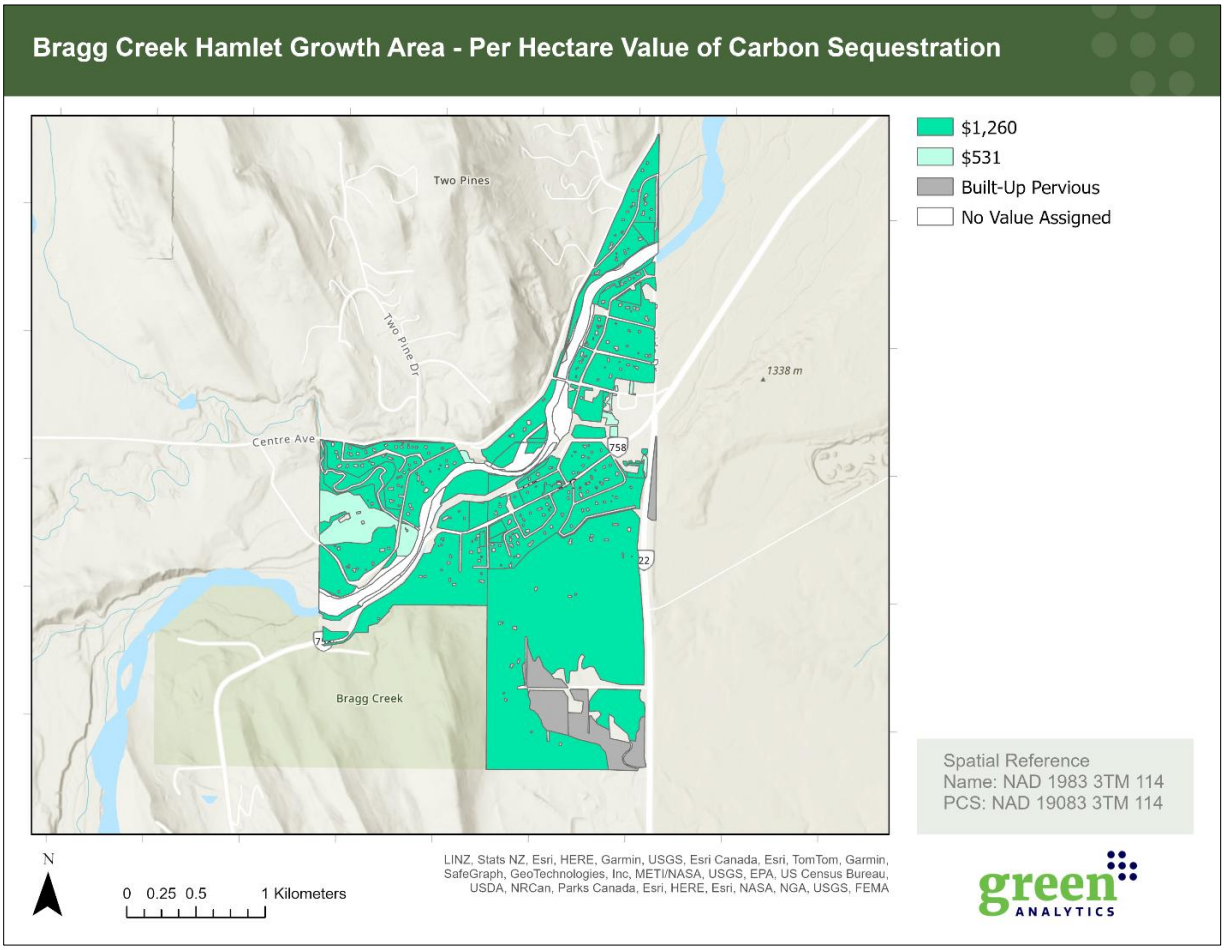


**Figure 11-4**. Bragg Creek Hamlet Growth Area per hectare values for carbon sequestration.

Total values of carbon sequestration by asset type are presented in Table 11-6. Taken together, the assets contribute $220,905 annually, or $0.22 million per year in carbon sequestration. Forest assets are the main source of value given their high sequestration potential on a per ha basis as well as their dominance within the Bragg Creek Hamlet Growth Area boundary generating $216,113 per year.

**Table 11-6.** Annual value of carbon sequestration for Bragg Creek Hamlet Growth Area by natural asset type.

| Asset Type | Annual Value of Carbon Sequestration | Percent |
|---|---|---|
| Forest | $216,113 | 97.83% |
| Grassland | $3,796 | 1.72% |
| Open Water | - | - |
| Sparsely Vegetated | $996 | 0.45% |
| Total | $220,905 | |
| Total, in millions | $0.22 | |

## 11.4.4 Value of Erosion Control

The spatial distribution of annual per ha erosion control values for the Bragg Creek Hamlet Growth Area is displayed in Figure 11-5. Forest assets are valued at $792.77 per ha while grassland and sparsely vegetated assets are valued at $81.14 for each ha.

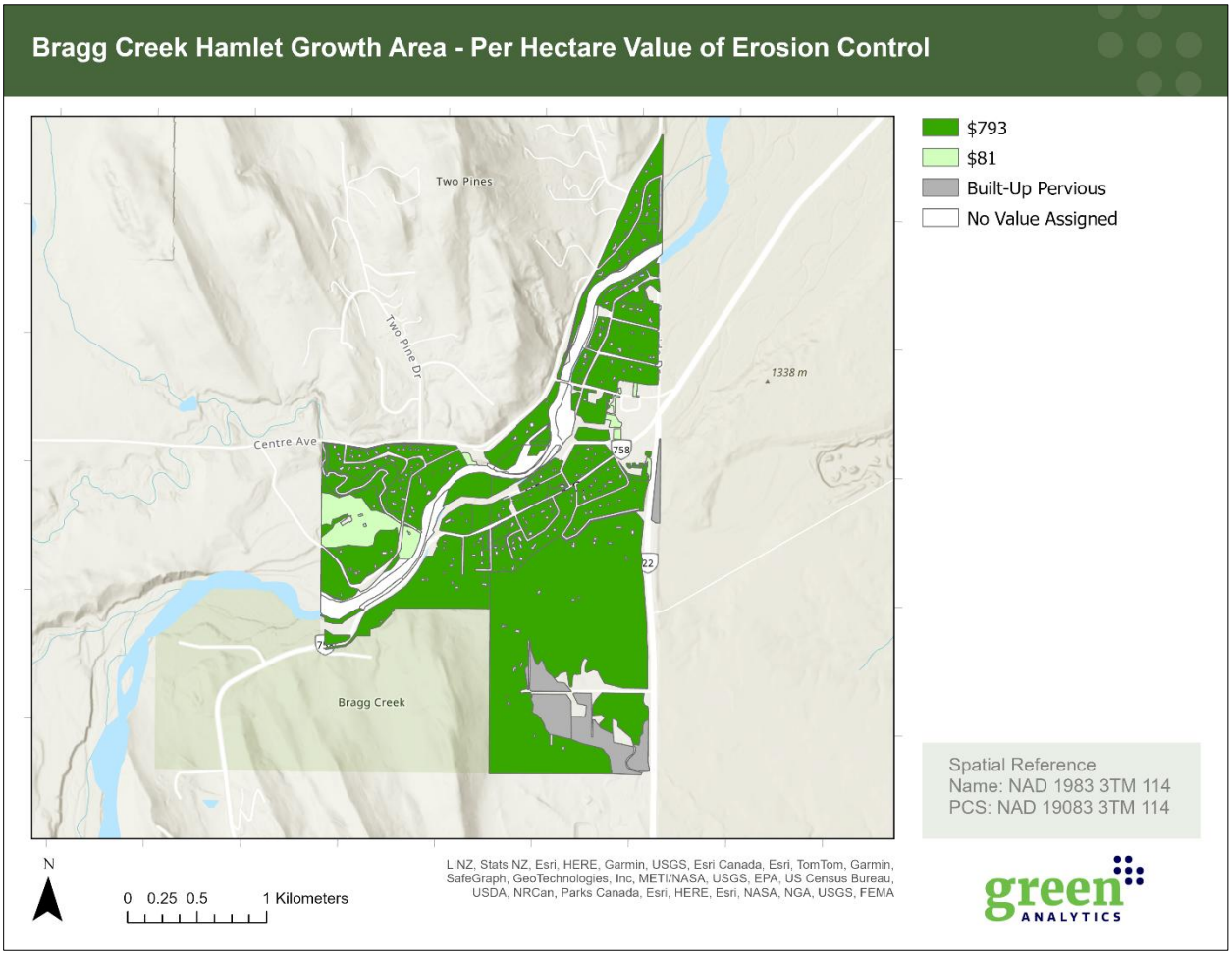


**Figure 11-5**. Bragg Creek Hamlet Growth Area per hectare values for erosion control.

The total estimated value of erosion control services in the Bragg Creek Hamlet Growth Area is $136,713 annually, or approximately $0.14 million, as shown in Table 11-7. The vast majority of this value—$135,980—

is attributed to forested land, reflecting the critical function that tree roots and dense vegetation play in stabilizing soil and reducing erosion across sloped or exposed terrain.

**Table 11-7**. Annual value of erosion control for Bragg Creek Hamlet Growth Area by natural asset type.

| Asset Type | Annual Value of Erosion Control | Percent |
|---|---|---|
| Forest | $135,980 | 99.46% |
| Grassland | $581 | 0.42% |
| Open Water | - | - |
| Sparsely Vegetated | $152 | 0.11% |
| Total | $136,713 | |
| Total, in millions | $0.14 | |

## 11.4.5 Value of Water Regulation and Flood Control

The spatial distribution of annual per ha values for water regulation and flood control within the Bragg Creek Hamlet Growth Area is depicted in Figure 11-6. Open water features and their nearby riparian zones exhibit the greatest per ha values at $2,306. Forest assets are valued at $1,008 per ha while grasslands and sparsely vegetated assets are valued at $10 per ha.

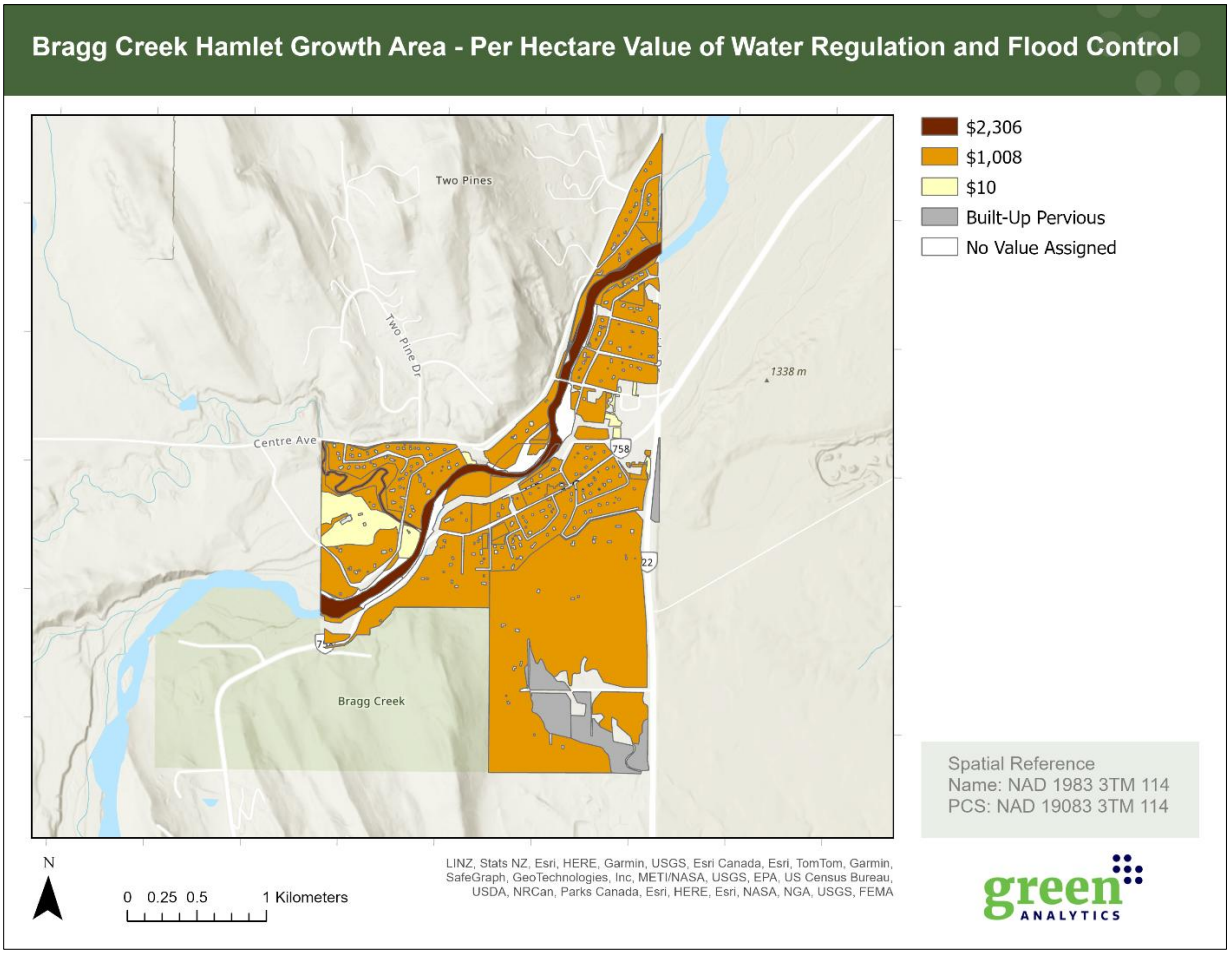


**Figure 11-6**. Bragg Creek Hamlet Growth Area per hectare values for water regulation and flood control.

The total annual value of water regulation and flood control services in the Bragg Creek Hamlet Growth Area

is estimated at $202,375, or $0.20 million (Table 11-8). Forested areas are the primary contributor, providing $172,871, which accounts for 85.42% of the total service value. This reflects the important role of forests in slowing runoff, promoting infiltration, and supporting watershed health. Open water features contribute $29,410, representing 14.53% of the total, due to their capacity to retain and store excess surface water during storm events.

**Table 11-8.** Annual value of water regulation and flood control for Bragg Creek Hamlet Growth Area by natural asset type.

| Asset Type | Annual Value of Water Regulation and Flood Control | Percent |
|---|---|---|
| Forest | $172,871 | 85.42% |
| Grassland | $74 | 0.04% |
| Open Water | $29,410 | 14.53% |
| Sparsely Vegetated | $20 | 0.01% |
| Total | $202,375 | |
| Total, in millions | $0.20 | |

## 11.4.6 Value of Water Purification and Waste Treatment

The spatial distribution of the Bragg Creek Hamlet Growth Area's annual per ha water purification and waste treatment values are shown in Figure 11-7. The map uses dark purple to denote areas with the highest per ha value of $4,981 which occur in open water features and their neighboring riparian zones. Forested lands are generally identified by areas shaded in medium purple which hold a value of $359 per ha. The light purple areas were assessed at $35 per ha and are associated with grasslands and sparsely vegetated assets.

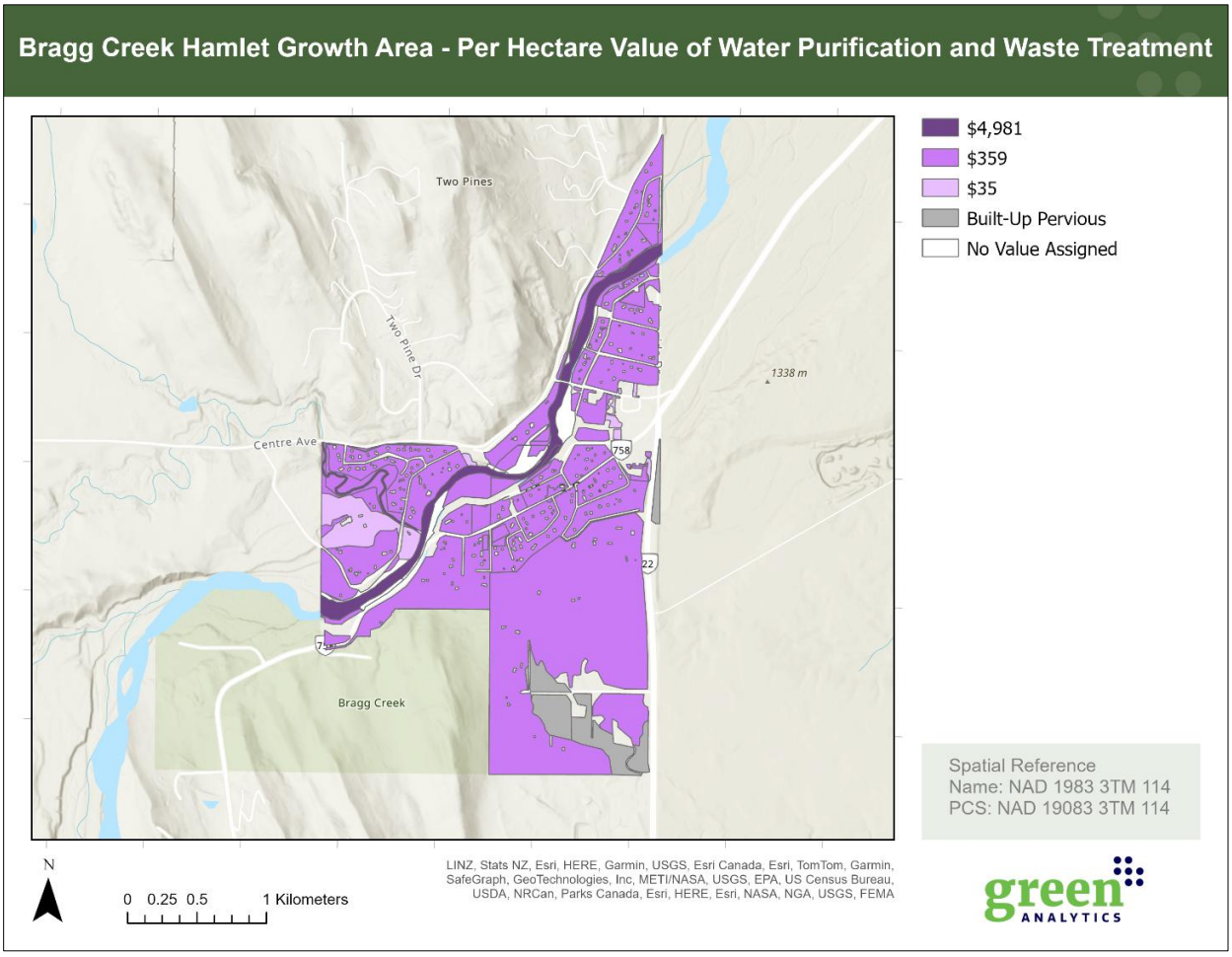


**Figure 11-7**. Bragg Creek Hamlet Growth Area per hectare values for water purification and waste treatment.

Water purification and waste treatment services provided by the natural assets in the Bragg Creek Hamlet Growth Area are valued at $125,482 annually, or approximately $0.13 million per year. As shown in Table 11-9, open water features are the largest contributor, accounting for $63,534, or 50.63% of the total. Forest assets contribute $61,629, representing 49.11% of the total.

**Table 11-9.** Annual value of water purification and waste treatment for Bragg Creek Hamlet Growth Area by natural asset type.

| Asset Type | Annual Value of Water Purification and Waste Treatment | Percent |
|---|---|---|
| Forest | $61,629 | 49.11% |
| Grassland | $253 | 0.20% |
| Open Water | $63,534 | 50.63% |
| Sparsely Vegetated | $66 | 0.05% |
| Total | $125,482 | |
| Total, in millions | $0.13 | |

## 11.4.7 Value of Habitat Provision

The spatial distribution of annual per ha habitat provision values across the Bragg Creek Hamlet Growth Area is depicted in Figure 11-8. The most valuable biodiversity habitat areas reach $3,049 per ha and appear as

dark green regions on the map. These are largely grassland and sparsely vegetated assets. Forest assets (depicted as lighter green) are associated with a per ha value of $1,187.

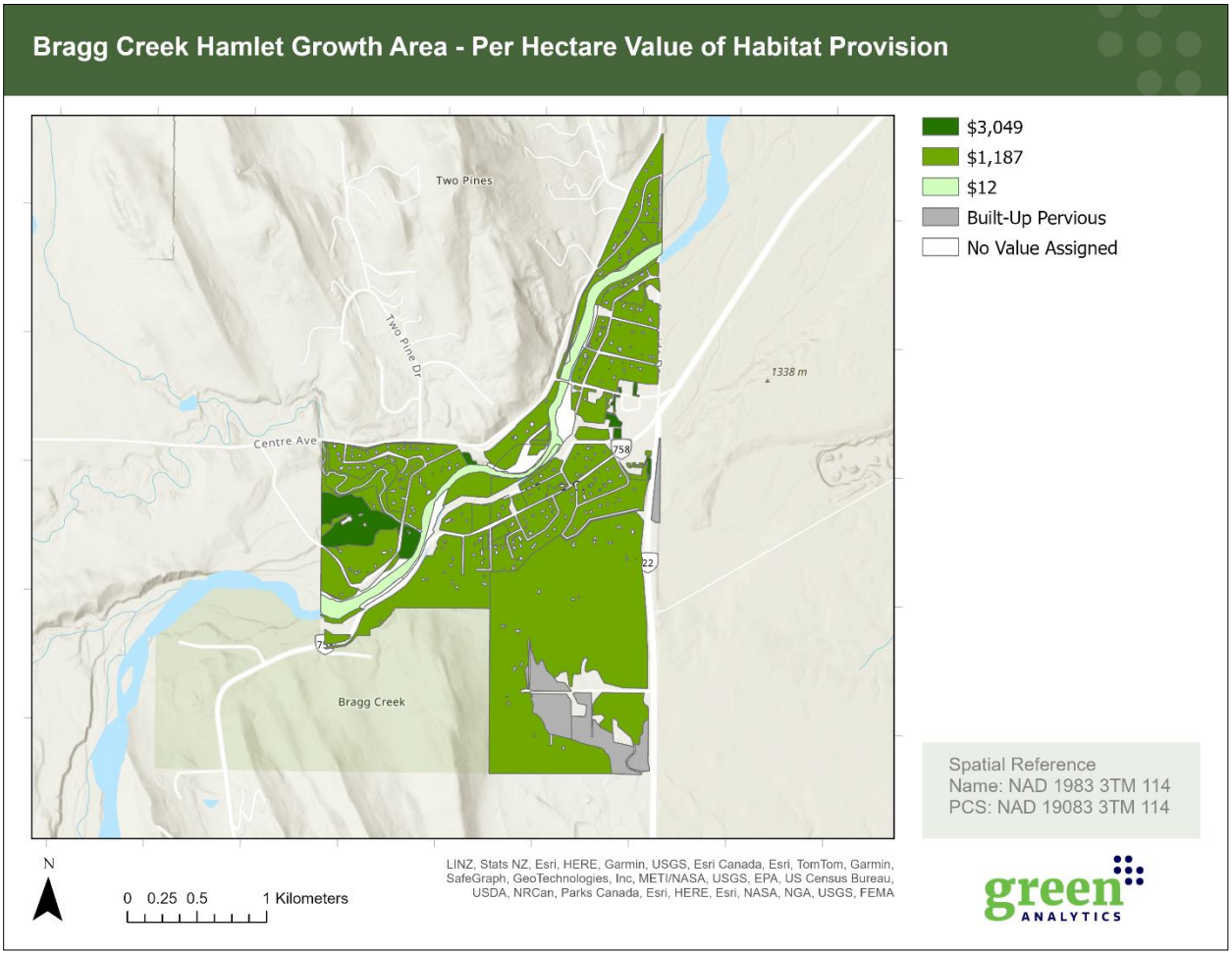


**Figure 11-8**. Bragg Creek Hamlet Growth Area per hectare values for habitat provision.

The estimated total annual value of habitat provision in the Bragg Creek Hamlet Growth Area is $231,265, or roughly $0.23 million, as shown in Table 11-10. Forests are by far the most significant contributor, providing $203,563, which represents 88.0% of the total value. Grasslands contribute $21,818, accounting for 9.4% of the total value, and sparsely vegetated assets are valued at $5,726 (2.5% of the total value). These figures emphasize the central role that forest and grassland systems play in supporting wildlife habitat within the Hamlet.

**Table 11-10.** Annual value of habitat provision for Bragg Creek Hamlet Growth Area by natural asset type.

| Asset Type | Annual Value of Habitat Provision | Percent |
|---|---|---|
| Forest | $203,563 | 88.02% |
| Grassland | $21,818 | 9.43% |
| Open Water | $158 | 0.07% |
| Sparsely Vegetated | $5,726 | 2.48% |
| Total | $231,265 | |
| Total, in millions | $0.23 | |

## 11.4.8 Value of Nutrient Cycling

The spatial distribution of annual nutrient cycling values per ha for the Bragg Creek Hamlet Growth Area is shown in Figure 11-9. Areas represented by dark purple shading, which are open water areas, show the highest per ha value of $858. The cream coloured areas hold a value of $718 per ha and primarily represent forested land cover types. Nutrient cycling in forest ecosystems happens through leaf litter deposition alongside root turnover and the presence of complex microbial communities found in undisturbed soils. Areas with light pink shading represent sparsely vegetated and grassland regions, which hold a value of $109 per ha.

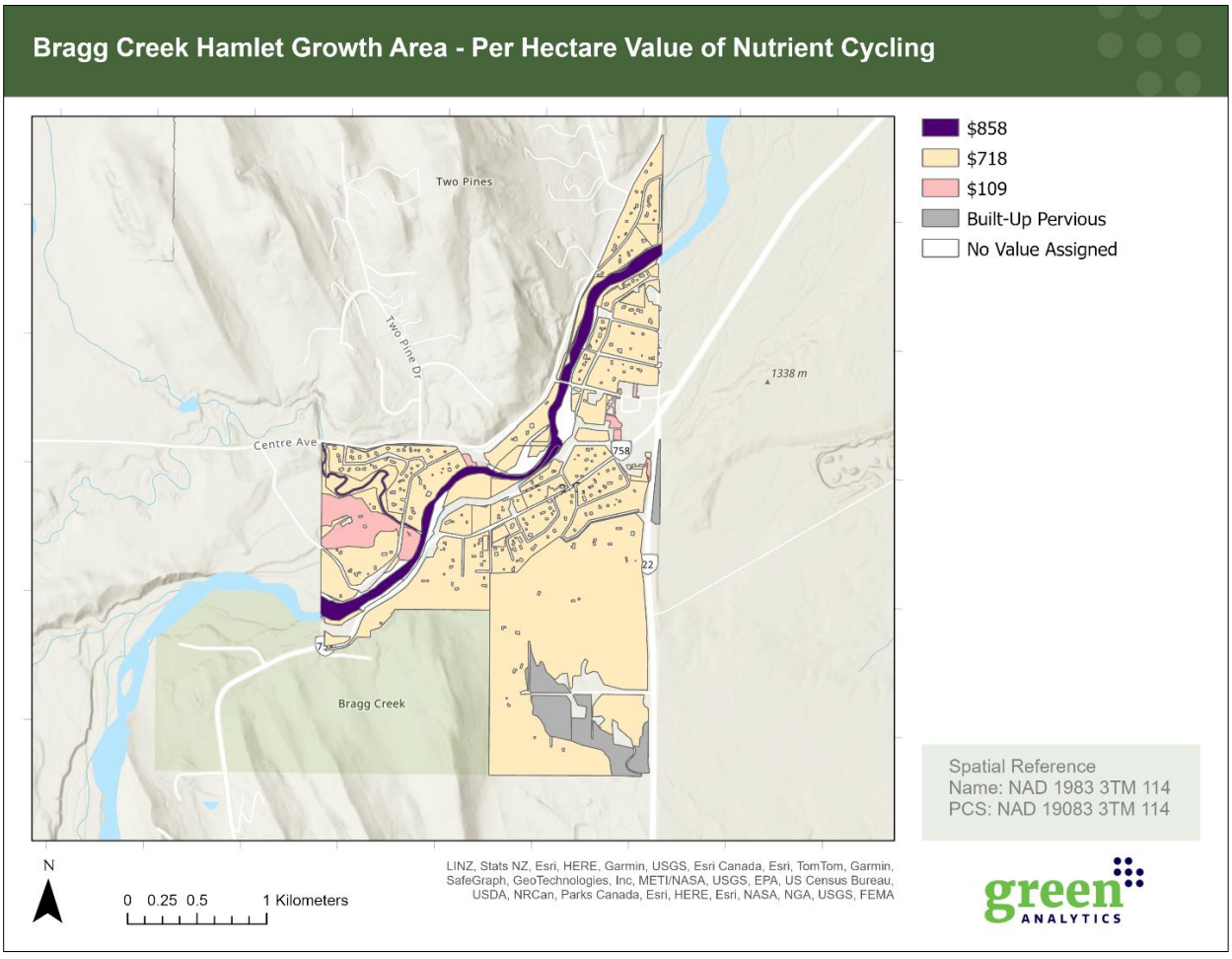


**Figure 11-9**. Bragg Creek Hamlet Growth Area per hectare values for nutrient cycling.

As is shown in Table 11-11, the total annual value attributed to nutrient cycling in the Bragg Creek Hamlet

Growth Area is approximately $135,078, or $0.14 million. Forested areas dominate this service, contributing $123,148, which equates to 91.17% of the total value. This is due to forests' rich organic matter and root systems, which support microbial activity and nutrient transformation. Open water bodies play a secondary but still notable role, generating $10,947, or 8.10% of the total value.

**Table 11-11**. Annual value of nutrient cycling for Bragg Creek Hamlet Growth Area by natural asset type.

| Asset Type | Annual Value of Nutrient Cycling | Percent |
|---|---|---|
| Forest | $123,148 | 91.17% |
| Grassland | $778 | 0.58% |
| Open Water | $10,947 | 8.10% |
| Sparsely Vegetated | $204 | 0.15% |
| Total | $135,078 | |
| Total, in millions | $0.14 | |

## 11.4.9 Value of Soil Formation

Annual per ha soil formation values for the Bragg Creek Hamlet Growth Area are displayed in Figure 11-10. The purple areas valued at $25 per ha consist mainly of forested regions where biological functions and root structures work together with litter decomposition to create enriched soil layers. Grasslands and sparsely vegetated lands typically fall within light blue zones which have a soil formation value of $11 per ha.

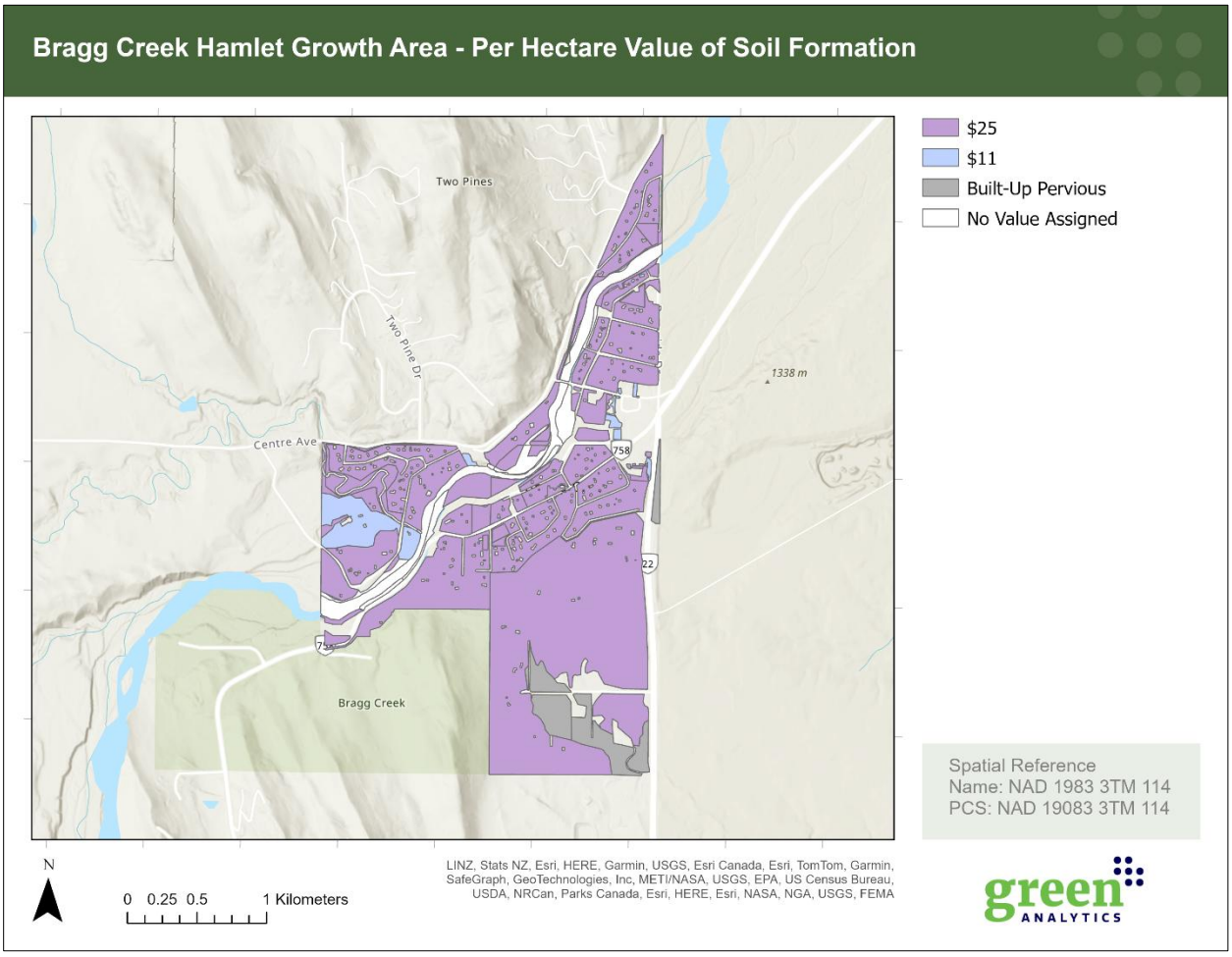


**Figure 11-10**.Bragg Creek Hamlet Growth Area per hectare values for soil formation.

The total annual value of soil formation services within the Bragg Creek Hamlet Growth Area is relatively modest, estimated at $4,380, or $0.004 million, as shown in Table 11-12. Despite the small total value, forested areas overwhelmingly support this function, contributing $4,277, which represents 97.65% of the total value.

**Table 11-12.** Annual value of soil formation for Bragg Creek Hamlet Growth Area by natural asset type.

| Asset Type | Annual Value of Nutrient Cycling | Percent |
|---|---|---|
| Forest | $4,277 | 97.65% |
| Grassland | $82 | 1.87% |
| Open Water | - | - |
| Sparsely Vegetated | $21 | 0.48% |
| Total | $4,380 | |
| Total, in millions | $0.004 | |

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