

Valuation of Natural Assets

Analysis Summary

November 12, 2021



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Introduction

Key Messages:

What is Natural Infrastructure?: It includes the natural spaces in our city, such as grasslands, forests and waterbodies, as well as items that we have built; those that use natural processes to manage water or provide some of natural functions of an ecosystem in an urban environment.

Why did we do this?: We're good at understanding the value of traditional assets, such as hard infrastructure like buildings and roads, but organizations can miss the value of services that the natural environment can provide. For example, forested areas in the urban environment retain stormwater, provide habitat, are used for recreation, and reduce the urban heat island effect. This study builds on the understanding of the intrinsic value of nature, to demonstrate that natural assets provide significant and measurable value to Calgarians in an urban setting.

Why does this matter?: Investments in natural infrastructure can have significant economic returns, many of which we are only now learning to measure. It can reduce our reliance on costly built infrastructure and can mitigate some effects of climate change. Natural infrastructure provides spaces for community connection and recreation for all life stages and serves to improve our city's livability.

How the results from this study can be used:

- The results can be used to report on the value of natural assets in Calgary, to improve municipal accounting and financial reporting by including these critical assets similar to other municipal assets.
- Through describing the valued services provided it can build the business case for improved preservation and conservation to protect land from disturbance.
- It can inform the value proposition for restoration of disturbed areas, to return ecological and hydrological function and services that have been lost due to urbanization.
- Natural assets, just like traditional assets, require operational maintenance and investment. While this study does not recommend the magnitude of necessary investment, it demonstrates that there is significant value at risk if natural assets fall into disrepair or require replacement. This can provide the background to ensure adequate funding and resourcing is assigned to the lifecycle needs of natural assets.

This study has demonstrated that natural assets provide significant value to the City of Calgary, in the range of **\$2.5 billion annually** (Table 1).

Table 1: Summary of Natural Asset Value within the City of Calgary

Priority Services	Recreation	Amenity and enjoyment	Habitat	Water Retention	Urban heat reduction	Carbon storage	Total
Annual service value	\$899 million	\$50 million	\$33.7 million	\$1.2 billion	\$381 million	\$1.8 to \$7.6 million	\$2.5 billion

Project Background

Natural infrastructure provides numerous societal, economic and environmental benefits, many of which can be assessed and quantified to describe a service economic value. However, traditionally these benefits are often undervalued or go unrecognized in financial processes, leading to an increased risk of mismanagement and loss of natural infrastructure. The City of Calgary has been developing a more holistic view of natural infrastructure as a key method in building a city that is resilient, particularly to the effects of climate change. This project was completed to better communicate the value of Calgary's natural assets and the services they provide to inform decision-making and planning around land use, asset management and operations.

What is Natural Infrastructure and Natural Assets

The City of Calgary considers natural infrastructure to include a range of assets which rely on ecological and hydrological processes to provide municipal, ecosystem and societal services (Figure 1). Natural assets within this spectrum include the grasslands, forests, riparian areas, watercourses, and wetlands in Calgary. For this project we will consider natural assets, in addition to public street trees.

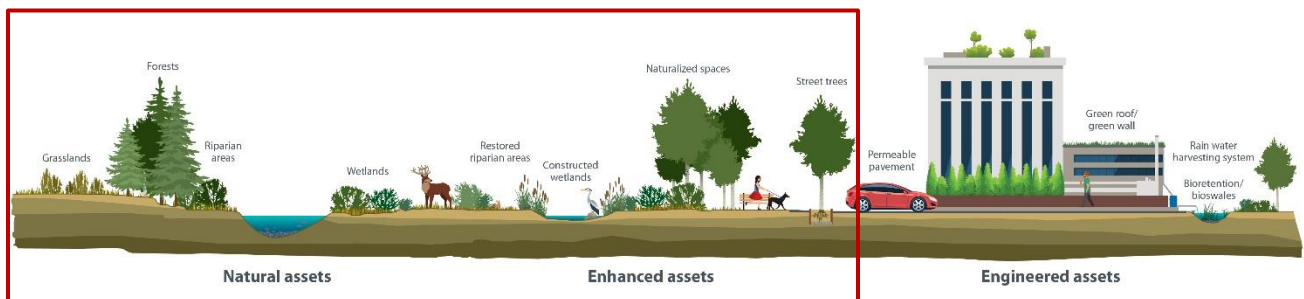


Figure 1: The spectrum of natural infrastructure in the City of Calgary, with the range of currently analysed natural assets noted within the red box.

Services provided by Natural Assets

Natural assets provide multiple services and a range of benefits. The services selected for valuation in this study include the following: recreation, amenity and enjoyment, habitat, water retention, urban heat reduction, and carbon storage. Natural assets are a climate resilient approach to managing climate change; reducing some impacts of climate change as well as storing carbon to reduce greenhouse gases in the atmosphere.

Project Deliverables

The project involved:

- A review of The City of Calgary's (The City) current natural asset inventory and the development of a natural asset dashboard. This online dashboard is a publicly accessible tool to display and track natural assets in Calgary. <http://go.greenanalytics.ca/calgary>

- Identification of priority services provided by select natural assets through an ecosystem services approach; and
- An evaluation demonstrating the financial value of services provided by natural assets within the City of Calgary.

Natural Asset Valuation

The assets included in this project are grasslands, forests and shrublands, watercourses, wetlands and street trees within The City of Calgary's municipal boundary (Table 2). Agricultural land within Calgary's municipal boundary was also assessed for some services. These particular assets were categorized based on datasets of land classifications available to The City and selected by the project team as indicative of the major natural asset types managed within the city footprint.

Table 2: Type and Extent of Natural Assets within the City of Calgary

Asset Type ⁽¹⁾	Area (ha)	Portion of Total Asset Area
Forest	2,218	8%
Grassland	7,641	28%
Shrubland	439	2%
Water	2,888	11%
Wetland	1,205	4%
Agricultural ⁽²⁾	12,875	47%
Total	27,267	100%

(1) Riparian areas overlap with multiple assets types, so were not assessed or valued separately to avoid double counting.

(2) Private agricultural land within the city boundary was considered during the valuation of water retention services and amenity value.

Service Prioritization

A subset of services was prioritized for financial valuation by subject matter experts from across the corporation including Calgary Parks (Urban Conservation and Urban Forestry), Water Resources, Environmental & Safety Management and Resilience & Infrastructure Calgary. Through a workshop, several services and benefits were identified, and then streamlined to reflect the groupings most representative of the many services provided within Calgary. Biodiversity, clean water, and clean air were noted to be foundational outcomes of functioning natural infrastructure, while also critical to the provision of the priority services themselves. Figure 2 shows the priority services identified for Calgary for this project were: recreation, amenity and enjoyment, habitat, water retention, urban heat reduction, and carbon storage.

During prioritization, the working group had to make scoping decisions to omit or exclude some critical services, such as fresh water provision, as that service itself is not directly tied to the land base within Calgary but delivered primarily in the source watershed.

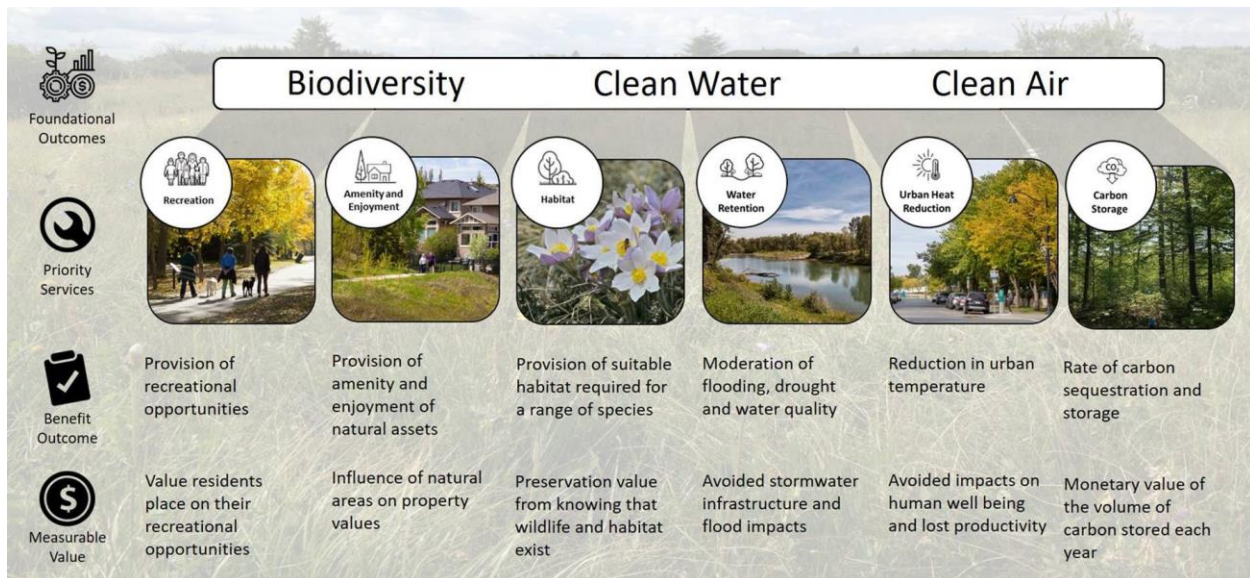


Figure 2: The summary of priority services provided by natural assets in Calgary.

Financial Valuation

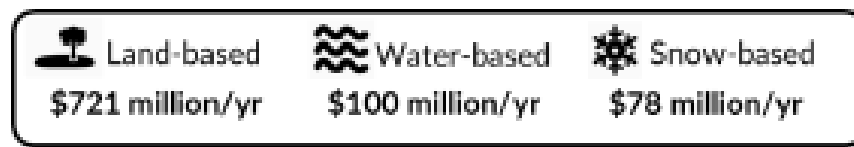
Various methods were used to calculate the value of each priority service informed by available data, literature research and North American precedents. In addition to the service valuation, a replacement valuation approach was used to describe the cost of replacing impacted or removed natural assets. Full details of the analysis and the cited literature can be found in the technical report prepared by Associated Engineering and Green Analytics. Summarized results of the financial valuation are provided below.

Recreation: \$899 million annually

Natural areas provide a space for Calgarians and visitors to pursue many types of outdoor recreation. The service value for recreation is assessed as the value that people place on engaging in recreational activities. It can be thought of as the maximum amount of money a person would be willing to spend for the recreational opportunity. Recreational activities included in the analysis were limited to the following, as these are most likely to occur within natural assets:

- Specific land-based activities: jogging/running, biking, picnicking, wildlife watching, birdwatching, geo-caching, going to parks, and hiking.
- Snow-based: cross-country skiing and tobogganing.
- Water-based activities: paddling, water sports, boating, canoeing and fishing.
- While likely to occur in natural areas, walking was not included in this analysis due to its prevalence on pathways and sidewalks not within natural areas.

The total value of land, snow and water-based recreation in Calgary is estimated at over **\$899 million** per year.



Amenity and Enjoyment: \$50 million annually

The amenity and enjoyment benefits from natural assets can influence a wide range of values from impacts on property values to an individual's sense of enjoyment moving around town. The valuation approach employed for amenity and enjoyment is based on a recent study on the value of open spaces in Okotoks, Alberta.¹ This study estimated the value of pasture and forests within 200 metres of residential properties as a percent of the value of the properties themselves (Table 3). These estimates were applied to tax assessment home values in Calgary to describe the amenity value from natural assets.

Table 3: Amenity value increase due to proximity to natural assets

Proximity to Natural Assets	Increase in Property Value
Forest land within 200 m	0.98%
Pasture land or grasslands within 200 m	2.78%

The annualized value assumes a 60-year lifespan and a 3% discount rate resulting in a value of approximately **\$50 million** due to the amenity and enjoyment of natural assets.

Habitat: \$33.7 million annually

Biodiversity is fundamental building block which provides all ecosystem services but is not easily measured on its own. The value of habitat, as a proxy for biodiversity, is frequently measured as the willingness to pay for species conservation or habitat protection. Willingness to pay values, while established in economic theory as appropriate measures of preservation, are inherently subjective as they are influenced by one's knowledge, beliefs, and attitudes. Such values come with degrees of uncertainty, so while the preservation estimate can help guide City decision making and policy development, it should not be used as a definitive measure to inform trade-offs. The value of habitat preservation for Calgary's open spaces (forest, wetland, grassland, and shrubland) is estimated to be **\$33.7 million per year**, or an average value of **\$2,930 per ha per year**.

¹ Cao, Y., Swallow, B., & Qiu, F. (2021). Identifying the effects of a land-use policy on willingness to pay for open space using an endogenous switching regression model. *Land use policy*, 102, 105183.

Water Retention: \$1.2 billion annually

Natural assets manage water through pooling in natural depressions, infiltration in permeable soil, and uptake through vegetation, playing an important role in both water quantity and water quality. Surface runoff management was the key focus of the Calgary-specific financial valuation completed in this analysis.

The first method used to value the water retention benefit of natural assets was based on research in other Canadian jurisdictions considering infiltration, runoff from various landcovers, and storage capacity. It resulted in a general estimate based on area of land cover and provides a value estimate of \$11.5 million/year (Table 4). This estimate was regarded as being on the very low end of the range of possible values associated with water retention.

Table 4: Unit Rate Value of Water Retention for Various Land Cover Types (Sani et al., 2018)

Asset Type	Hectare	Hectare / Year
Forests	\$61,425	\$1,755
Open Green Spaces	\$22,050	\$630
Wetlands	\$43,050	\$1,230

A second, more specific method using City of Calgary depression mapping, quantified the volume of surface ponding storage available within natural assets. Typical costs for constructed stormwater infrastructure were compared with water storage capacity in natural depressions. Two values, one for developed areas, and one for future development, were used to describe the cost of building stormwater storage solutions (Table 5). The depression volume method provided a water retention value of **\$1,166 million/year**.

Table 5: Value of Surface Water Storage from Natural Depression Areas in Calgary

Parameter	Developed Areas (Inside of the TUC)	Future Development Areas (Outside of the TUC)
Natural Depression Area (ha)	1,900	2,700
Natural Depression Volume (m ³)	21,000,000	30,000,000
Unit Rate (\$/m ³)	1,000	300
Cost	\$21,000,000,000	\$9,000,000,000
Total Capital Cost	\$30,000,000,000	
Total Annualized Cost ⁽¹⁾	\$1,166,000,000	

(1) Total capital cost is annualized assuming a 50-year lifespan of the assets and 3% discount rate.

Current development and stormwater management design practices diminish the water storage capacity of the landscape by about 30% to 50% from its predevelopment (e.g. agricultural) state.

Urban Heat Reduction: \$381 million annually

Natural assets within developed areas provide valuable temperature regulation services in areas that can be heavily impacted by urban heat island effects. Research shows that greenspaces within urban environments are much cooler than developed portions of urban areas and even reduce average temperatures in areas immediately adjacent to greenspace, as is visually displayed on the City's Urban Heat Island map².

The reduction in surface air temperature resulting from natural areas in Calgary was estimated to result in approximately **28 avoided heat-related deaths per year**. In addition, the reduction in surface air temperature due to street trees was estimated to result in approximately **18 avoided heat-related deaths per year**. These avoided deaths are valued at **\$226 million per year and \$155 million**, respectively for natural assets and street trees. Communities with higher median incomes show a slightly lower maximum surface temperature, suggesting inequity in community exposure to urban heat impacts.

Carbon Storage: \$1.8 million to \$7.6 million

Natural assets provide valuable carbon storage (the total stock of carbon stored in a given unit of nature) and sequestration (the net addition of carbon stored in a given unit of nature over a specified period of time, typically one year). Since other service values considered in this study are measured as annual rate, for this analysis sequestration rates (rather than storage) are used. Rates of carbon sequestration can vary by specific vegetation, soil, age of plant material and ecosystem structure, and general values are used for this analysis (Table 6). Additionally, lands may transition from agriculture lands to developed lands thereby losing their ability to sequester carbon. At **\$40 per tonne CO₂e**, the value of carbon sequestration is approximately **\$1.8 million per year**. This increases to **\$7.6 million** at a price of \$170 per tonne CO₂e per year.

Table 6: Carbon Sequestered per Year by Calgary's Natural Assets

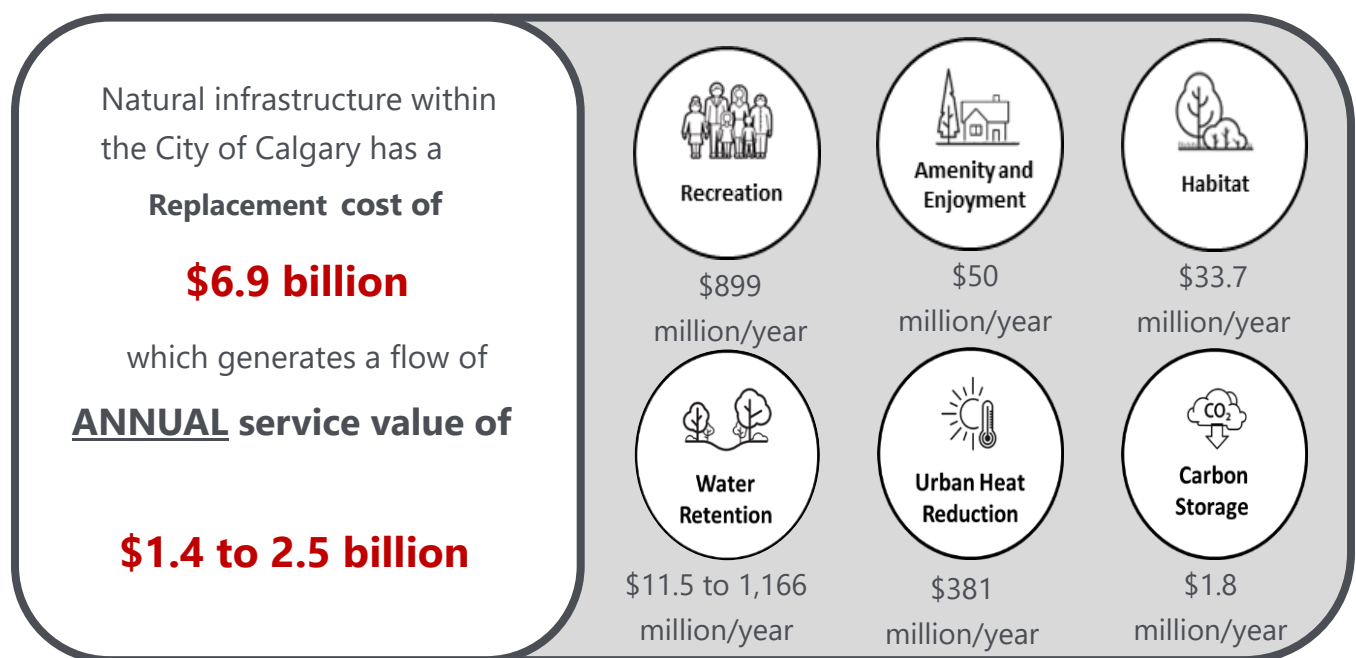
Land cover type	Sequestration rate (tonnes of carbon /ha/yr)	Area (ha)	Sequestration (tonnes of carbon /yr)	Sequestration (tonnes of CO ₂ e / yr)	\$40/tonne CO ₂ e /yr	\$170/tonne CO ₂ e /yr
Wetland	1.88	1,205	2,265	8,313	\$300,000	\$1,400,000
Forest	1.75	2,218	3,882	14,247	\$600,000	\$2,400,000
Grassland	0.63	7,641	4,814	17,667	\$700,000	\$3,000,000
Shrubland	0.63	439	276	1,013	\$40,000	\$200,000
Agriculture – pasture/fallow	0.63	1,636	1,031	3,784	\$150,000	\$600,000
Total			12,268	45,024	\$1,790,000	\$7,600,000

²Urban Heat Island Map developed for the City of Calgary. Not publicly available at this time.
<https://uat.resilientsolutions.futurecitiescanada.ca/>

Replacement Value

The replacement value is a measure of what it would cost The City to replace damaged or destroyed assets. For natural assets, the replacement cost is considered equivalent to the cost of restoration and totals at least **\$6.9 billion**. There are important differences between natural assets and built assets when considering replacement costs:

- (i) **Replacing natural assets can take a long time:** when replacing a natural asset, it can take many years, or decades, to get the level of service provision back to what it was before the asset was lost or damaged.
- (ii) **Natural assets appreciate over time:** the service provision of natural assets which have been replaced or restored increases over time, unlike traditional infrastructure which tends to depreciate over time.
- (iii) **It is not always possible to completely replace a natural asset's structure, process and functioning and therefore the services from those assets.** For example, most constructed wetlands are less able to provide the full natural structure, process and functioning of naturally occurring wetlands.



Next steps

The values described above attempt to quantify a fraction of the benefits from natural assets. This analysis has demonstrated the significant value that natural assets provide to the City of Calgary. The following areas of work could be considered for next steps (Figure 3):

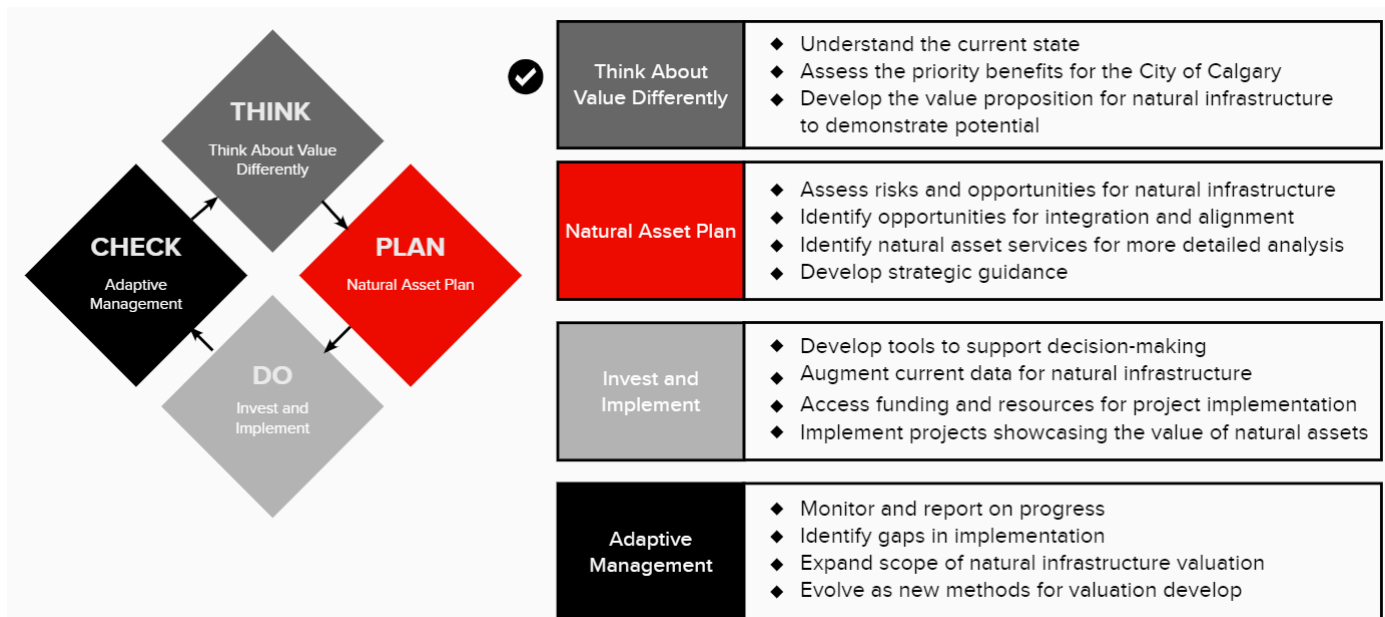


Figure 3: Next steps to continue integrating natural assets into City decision making and policy development.

As we better understand natural assets to be a critically important piece of municipal infrastructure, the need to effectively resource their protection, restoration and construction, through land use planning, municipal budgeting and decision making becomes clearer. Natural assets provide ecosystem services that improve municipal service provision, city livability, and residents' health and enjoyment of their communities. They are a fundamental component in meeting Council's goal of a healthy and green city. The analysis supports continued and ongoing investment to conserve, enhance and maintain natural assets, so we continue to benefit from the services provided. The analysis provided in this project can help to inform business case decisions, land use planning, asset management and operational investment to improve service provision from natural assets. Improved alignment of initiatives to support natural assets can help to realize maximum benefits to citizens and the corporation, and support climate resilience in Calgary.

Natural assets can provide multi-benefit solutions to a number of challenges, and with appropriate life cycle approaches to operations and renewal they can increase in value over time. Through this work, the City of Calgary is beginning to illustrate a deeper understanding of natural infrastructure and the benefits provided to all Calgarians.