PAINTED FOREST CARBON PROJECT

Document Prepared by Ostrom Climate Solutions (Canada) Inc.

For Perimeter Forest Limited Partnership

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1 PROJECT DETAILS

1.1 Summary Description of the Project

The Painted Forest Carbon Project creates GHG offsets and forest health benefits through the purchase and management of 59,846 ha (147,882 acres) of private forest land, located in the District of Algoma near Sault Ste. Marie, Ontario, Canada. The property is in a unique geographic location that will contribute to landscape level forest connectivity between the already established Lake Superior Provincial Park and Algoma Headwaters Provincial Park. The project avoids GHG emissions that would occur from harvesting the existing forestland. In the project scenario, significant carbon stocks are retained and sequestered through the preservation and continuing growth of the forest, creating substantial net benefits for Ontarians, and providing biodiversity benefits from the conservation and management of the area's forest ecosystem.

The Painted Forest Carbon Project achieves net GHG emission reductions and removals through the avoidance of emissions due to harvesting in the baseline scenario, and by increasing carbon stored by biomass growth in the retained forests on the project area in the project scenario.

Prior to the project, the property was being sold privately. The project proponent commissioned an appraisal of the property to assess its value, and included the net present value of timber on the property. The value of the property is based on a typical private land management regime. The most likely baseline scenario is a market-driven purchaser who intends to pursue immediate harvest of mature timber stocks to maximize cash value of fibre growing on the property. Under the baseline scenario, a harvest schedule of 151,297 m^3/year was selected, based on the typical regional common practice of targeting merchantable timber through diameter limit and clear cut harvesting common to private forestlands in Ontario and comparable regional silvicultural practices. It represents the annual harvest of forest-wide growth rate and is informed by the 2016 Ontario eFRI dataset[1] which is grown forward to end-2021, with harvest depletions from the eFRI issue date to end-2021 accounted for.

The project scenario is improved forest management, wherein PFLP undertakes the forest carbon project and associated ecosystem protection and enhancement activities. The project scenario includes a low level of timber harvesting as part of forest management activities for the purposes of forest health, incidental infrastructure, ecosystem resilience, biodiversity and other conservation objectives.

[1] https://www.ontario.ca/page/forest-resources-inventory

PFLP is a proponent of applying technological advancements to forest management and as such is funding the development of a high-resolution inventory of the project area using remote sensed data (LiDAR & 4band imagery), ground plot sampling, and advanced modelling. The enhanced forest inventory will be included in the project plan. Additionally, the traditional permanent sample plot inventory will be provided to the verifiers. This project will demonstrate the advantages of the inventory approach chosen and will enable the application of remote sensing methodologies to future forest carbon projects in North America.

The Painted Forest IFM-LtPF carbon project is forecast to generate approximately 10,664,945 million tCO_2e emissions reductions over 40 years on an ex-ante basis; the crediting period is 100 years. Annual average net emission reductions are projected to be between 222,789 and 298,224 tCO2e, averaging at 266,624 tCO2e annually.

1.2 Sectoral Scope and Project Type

Sectoral Scope	Sector 14: AFOLU
AFOLU project category	Improved Forest Management (IFM)
Activity Type	Logged to Protected Forest (LtPF)
Grouped	This is not a grouped project

1.3 Project Eligibility

This project qualifies as an eligible VCS IFM activity because it increases carbon sequestration and reduces GHG emissions on forest lands managed for wood products, and increases biomass carbon stocks by reducing harvest. The baseline and project scenarios for the project shall qualify as forests, defined by Natural Resources Canada as geographic areas with similar dominant tree species and stand type, and shall remain forests such as set out in the IPCC 2006 Guidelines on National GHG Inventories. As fee simple private lands, the project area qualifies and was historically used for wood product extraction.

The project meets the VCS IFM eligibility requirements outlined in the VCS Standard v4.3[2] as follows:

- The project increases carbon sequestration and/or reduces GHG emissions on forest lands managed for wood products by increasing biomass carbon stocks through improved forest management practices.
- The baseline and the project scenarios both involve activities where forests remain forests. Forest areas are retained as forest after harvest, with no material land conversion other than for forest roads required to support forest management.
- As fee simple private lands, the project area is approved for wood product management.

[2] https://verra.org/wp-content/uploads/2022/06/VCS-Standard_v4.3.pdf

- The project meets the VCS LtPF eligibility by converting harvestable forests to conservation forests.

1.4 Project Design

The project is located on a single and contiguous area of land (bisected by a rail right-of-way and transmission line corridor) and is designed to include multiple project activity instances, including conservation-based forest management activities, such as reduced harvesting and forest management techniques necessary for forest health (thinning, etc).

Eligibility Criteria

The project is not a grouped project.

1.5 Project Proponent

Organization name	Perimeter Forest Limited Partnership
Contact person	Mark Balogh, RPF
Title	Land Management & Offset Development Forester
Address	624 Huron Terrace, Kincardine, Ontario, N2Z 2H2
Telephone	+
Email	mbalogh@perimeterforest.com

1.6 Other Entities Involved in the Project

Organization name	Ostrom Climate Solutions (Canada) inc.
Role in the project	Project Development Consultant
Contact person	Eleri Harris
Title	Forest Carbon Project Manager
Address	948 Homer St #300, Vancouver, BC V6B 2W7
Telephone	+1 (604) 724 4789
Email	eleri.harris@ostromclimate.com

Organization name	Tesera Systems Ltd.
Role in the project	Enhanced Forest Inventory Developers
Contact person	Michael Kieser
Title	Chief Data Engineer
Address	P.O. Box 91073 RPO, Calgary, AB T3G 5W6
Telephone	+1 (406) 973-3277
Email	michael.kieser@tesera.com

Organization name	Silvacom Ltd
Role in the project	Growth and yield modeling
Contact person	Alex Bilyk
Title	Manager, Inventory Innovation
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Telephone	807-698-5686
Email	alex.bilyk@silvacom.com

1.7 Ownership

The Painted Forest project area property is owned by Perimeter Forest General Partner Inc. (PFGP) on a fee simple basis. The documentation of the sale and of land title will be provided to validators to demonstrate ownership. PFGP is the general partner of Perimeter Forest Limited Partnership (PFLP), who is the project proponent.

1.8 Project Start Date

Project Start Date: 02 September 2021

The project start date is the date that PFLP completed the acquisition of the Painted Forest property.

1.9 Project Crediting Period

Project Start Date: 02 September 2021

Project End Date: 01 September 2121

Crediting Period: 100 years

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	✓
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
2021	222,789
2022	234,505
2023	244,105
2024	247,915
2025	251,581
2026	255,110
2027	258,513
2028	251,357
2029	253,017
2030	254,560
2031	256,036
2032	251,148
2033	251,808
2034	244,524
2035	244,165
2036	244,167
2037	260,185

2038	263,161
2039	284,067
2040	285,777
2041	288,572
2042	291,240
2043	293,787
2044	279,321
2045	278,982
2046	280,551
2047	282,058
2048	283,505
2049	295,954
2050	293,870
2051	295,376
2052	296,825
2053	298,224
2054	292,904
2055	261,961
2056	261,605
2057	261,246
2058	260,888
2059	260,535
2060	249,051
Total estimated ERs	10,664,945 (over first 40 years)
Total number of crediting years	100
Average annual ERs	266,624 (first 40 year average)

1.11 Description of the Project Activity

The Painted Forest project will generate net GHG emission reductions and increase carbon sequestration in forest biomass by reducing the allowable harvest outlined in the baseline scenario by an average of 80%, annually. Project activities are designed to be integrated with all property management plans.

The project activities are largely focused on forest conservation management practices that have no material impact on carbon stocks. Limited timber harvesting – which does have material impact on carbon stocks – is, however, included for the purpose of long-term forest ecosystem resilience. This will include small-scale commercial timber harvesting, and thinning. Direct carbon-associated benefits of these activities include fire and pest risk mitigation, and improved forest productivity. Co-benefits of these activities include sustainable improvements in forest habitat and biodiversity and ecosystem resilience, support of culturally sensitive forestry practices, and ongoing employment opportunities for local contractors and community members.

The project is not located in a jurisdiction covered by a REDD+ program.

1.12 Project Location

The property is located in north-central Ontario, Canada, in the District of Algoma; approximately 80 kilometres north of the city of Sault Ste. Marie and 30 kilometres east of Lake Superior (Figure 1). It measures 147,882 acres of timberland and is a contiguous block, bordered on the north side by the Montreal River.

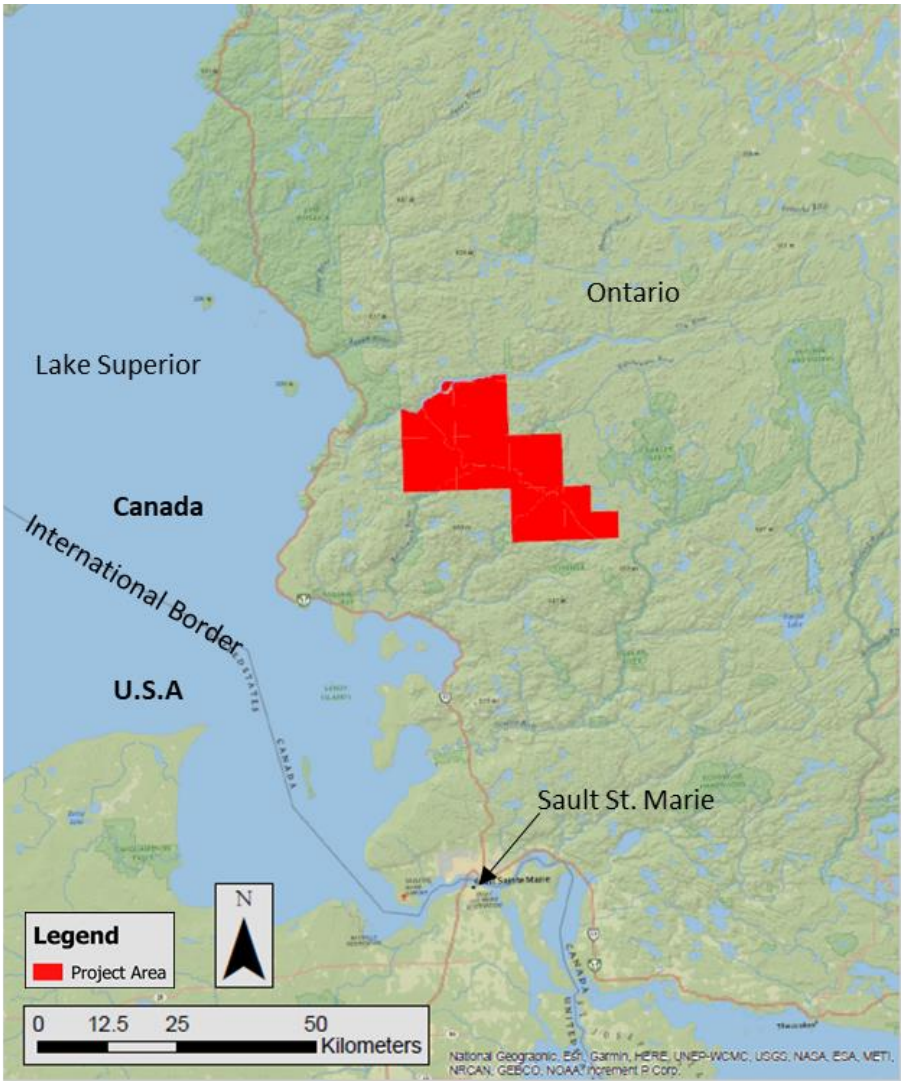


Figure 1. Regional location of the project area

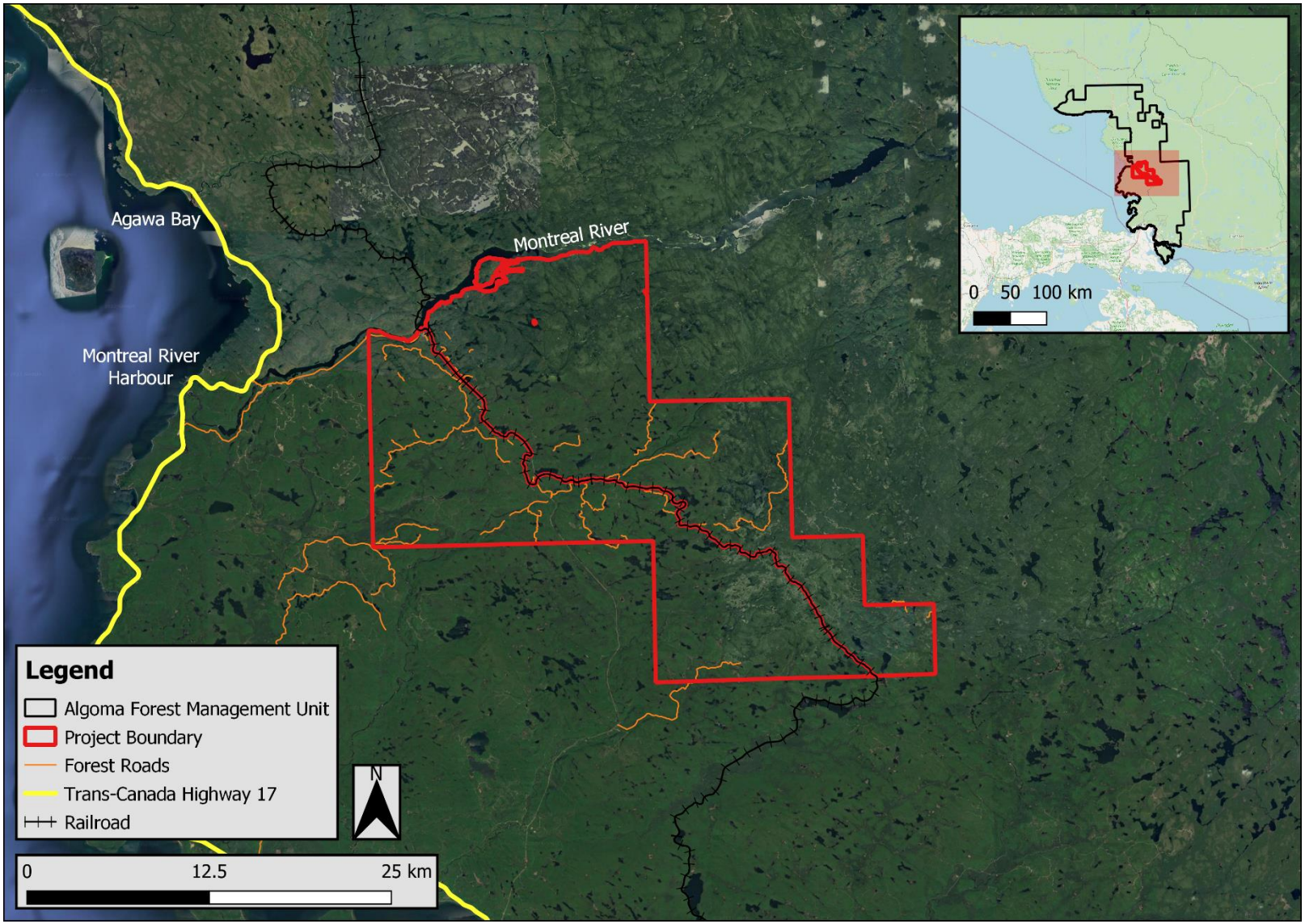


Figure 2. Project boundary, Watco Rail corridor intersecting the property, and local road networks within the property.

The property consists of 9 contiguous townships: Davieaux, Vibert, Tronsen, Tolmonen, Raaflaub in their entirety, and portions of Desbiens, Loach, Larson and Home. It can be accessed by five points of access, through unmaintained public road systems (Figure 2). Four of these access points are through the TransCanada HWY 17, north of Sault Ste. Marie, and one is off HWY 532 from the town of Searchmont. It can also be accessed via the Watco railway, passing through each township, which intersects the property in a northwest-southeast orientation. The railway corridor is owned by Watco rail, and is not part of the property. Harvest operations on the property have utilized three freight sidings along the Watco rail line to bring timber to market. Despite this internal road network, the property is still considered remote.

Three main waterways flow through the property: the Chippewa, Batchawana and Montreal Rivers. There are also several lakes on the property. The property is bordered on the north by the Montreal River, dividing the predominately northern hardwood forest types to the south from the more boreal forest types to the north.

1.13 Conditions Prior to Project Initiation

Ownership History

Prior to PFLP's acquisition of the property in 2021, the Painted Forest property was owned and managed by Quercus Algoma Corporation since January 2014. Historically, the Algoma Central Railway was awarded the townships north of Sault Ste. Marie in the late 1800s, and conducted timbering operations on the land into the mid-20th century. In 1995, the land was sold to McDonald Investments, who utilized the land for commercial timber harvesting with annual harvest rates reaching approximately 150,000m^3. In 2005 the property sold to Algoma Timberlakes Corporation (ATC). ATC originally planned to continue harvesting the land at the previous rates, but the global recession limited cutting operations to 168,000 m^3 over their 8 years of ownership allowing for an accumulation on unrealized merchantable timber volume. The property was then purchased by Quercus Algoma Corporation in 2014 commercial timber harvesting was restarted with management plans with an annual harvest rate of 70,000 m^3/year and a ratcheting up of harvest to approximately 150,000 m^3/year by 2020 to capture the unrealized volume from previous years..

Climate

The project area is located in the Ontario Shield ecozone, and the Georgian Bay Ecoregion, and experiences a cool-temperate and humid climate. It is characterised by humid and cool weather,

with annual precipitation between 771 to 1,134 mm/year[3]; the wettest months being September and November and the mean summer rainfall between 204 and 304 mm. Mean annual temperatures range from 2.8 to 6.2 °C. Winters are cold, but milder than some inland areas due to heat from Lake Superior. The mean growing season length is 183-219 days.

Land Cover

For context, the the region's forests consist of 33.0% mixed forest, 12.1% coniferous forest, and 22.2% deciduous forest. Much of the forested area surrounding and within the subject property is dominated by northern hardwood. Lakes and rivers occupy the property and the surrounding area.

The regional Algoma forest, a designated crown sustainable forest licence area, encompasses an area of 1,565,141 ha, of which approximately 47% is unencumbered Crown land eligible for management, 9% is protected in parks or conservation reserves, 35% is held under private patent, 2% is held as federal reserve land or under some other special designation, and 7% is water.

Notable Species

Several species of note have been identified on the property, according to the Threatened and Endangered Species Evaluation conducted by Geo-Source Inc.[4], and are itemised in the Threatened and Endangered Species section below. No other endemic or specialist species are known on the property.

Threatened and Endangered Species

A review of Threatened and Endangered Species on/around the Painted Forest Property was carried out by Geo-Source Inc. in January 2014. The following findings are of species with known occurrences on the property.

- Birds: Peregrine Falcon (*Falco peregrinus*), sighting in northern Home Township, known nesting north of property along Montreal River. They are a Species of Special Concern in Ontario.

[3] https://www.ontario.ca/page/ecosystems-ontario-part-1-ecozones-and-ecoregions

[4] Geo-Source, Inc. Threatened and Endangered Species Evaluation, Algoma Property. 147,882 +/- Acres of Timberlands, Algoma District, Ontario, Canada. January 2014.

- Reptiles: The wood turtle (*Glyptemys insculpta*) has an Area of Concern (AOC) in the southwestern portion of the property, identifying this area as a High Conservation Value Forest (HCVF). This habitat qualifies as designated wood turtle habitat according to the Ontario Endangered Species Act (2007). They are an Endangered Species in Ontario, and Threatened Species in Canada.
- Myotis bat species are likely on the property and will be managed according to PFLP bat management guidelines. Little Brown Myotis (*Myotis lucifugus*) and Northern Myotis (*Myotis septentrionalis*) are Endangered Species in Ontario.

Land Use

Commercial forestry is the predominant land use in the region, along with outdoor recreation, hunting, trapping, and fishing. There are 211 recreational leases on the property, mostly waterfront, and one trapper cabin lease.

There are also nine commercial leases on the property, eight storage leases, as well as one industrial lease with a hydroelectric operator on the Montreal River.

The property is within the Algoma Forest which either surrounds or is adjacent to 35 provincial parks and conservation areas and one National park. Provincial Parks near the property include Lake Superior, Batchawana River (abuts property north and south), and Algoma Headwaters.

Forest Species

The forest types and their acreages in the operable forested area of the project area are outlined below in Table 1, while Table 2 provides an acreage summary by timber type. The most common forest types on the property are tolerant hardwood (dominated by hard (sugar) and soft (red) maples and yellow birch, with white spruce, balsam fir and white pine mixed throughout the stands. Intolerant Hardwoods are mostly trembling aspen and/or white birch and tend to be on lower ground mixed with Spruce/Fir types. The Spruce/Fir type contains a mix of species of Intolerant Hardwoods and other species. Mixedwood describes a common mix of Spruce/Fir and Intolerant Hardwood; generally spruce, fir, poplar, and white birch. Lowland conifer stands are mostly black spruce, with northern white-cedar and larch mixed in. Stands dominated by cedar are present, but less common.

Table 1. Operable Forested Area Summary[5]

Superstratum	Acres	% Total
Tolerant Hardwoods (TH)	47,510	39%
Intolerant Hardwoods (IH)	14,187	12%
Spruce/Fir (SPF)	16,131	13%
Cedar (CE)	6,091	5%
Immature	36,540	30%
Total	**120,459**	**100%**

* The area and timber type summaries will be updated with the latest eFRI dataset.

Table 2. Acreage Summary by Timber Type [5]

March 31, 2021		
By Timber Type		
Forested Type	**Acres**	**Percent**
Premerchantable Aspen/WBirch	5,178	3.5%
Merchantable Aspen/WBirch	17,578	11.8%
Premerchantable Northern Hardwoods	265	0.2%
Merchantable Northern Hardwoods	76,945	51.9%
Premerchantable planted pine	426	0.3%
Premerchantable Lowland Softwood	1,978	1.3%
Merchantable Lowland Softwood	17,112	11.5%
Premerchantable Upland Softwood	1,143	0.8%
Merchantable Upland Softwood	10,662	7.2%
Forested Subtotal	**131,285**	**88.5%**
Non-Forest	17,065	11.5%
Non-Forest Subtotal	**17,065**	**11.5%**
All Acres	**148,350**	**100%**

Social

Several Indigenous communities reside in the Algoma Forest in proximity to the Painted Forest property, including:

- Batchewana First Nation;
- Missanabie Cree First Nation;
- Michipicoten First Nation;
- Garden River First Nation; and
- The Métis Nation of Ontario Historic Sault Council.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

[5] Quercus Algoma Corporation, Algoma Property Ten-Year Management Plan, July 2014

This forest carbon project is designed to comply with Canadian and Ontario laws, statutes, and regulations, in both the baseline and project scenarios. Land use regulations for private timber management in Ontario are minimal, with regulation confined to stream crossings at this time. Impacts of zoning and regulations on the property are minimal.

Provincial Laws, Statutes, and Regulations

- **The Planning Act (1990)** – Ontario Ministry of Municipal Affairs and Housing
    - **Relevant Section**: 1.1.6.1: Territory Without Municipal Organization
    - **Purpose:** On rural lands located in territory without municipal organization, the focus of development activity shall be related to the sustainable management or use of resources and resource-based recreational uses (including recreational dwellings)
    - **Details**: The Painted Forest Carbon Project area is located on lands without municipal organization, and the focus in development in the project scenario is sustainable management of the property.
- **Ontario Approved Water Crossing Standards (Updated 2021)** – Ministry of Natural Resources and Forestry and Fisheries and Oceans Canada: Protocol for the review and approval of forestry water crossings
    - **Purpose**: Among other things, The Ontario approved water crossing standards outlines guidelines for areas such as erosion and sediment control, fish and fish habitat, and construction and maintenance. These standards must be implemented consistently with applicable and approved Forest Management Plans and must be overseen by trained individuals.
    - **Details**: The stream crossings within the project boundary will adhere to the approved water crossing standards for the Province of Ontario
- **Professional Foresters Act (2000)** – Statutes of Ontario
    - **Purpose:** This legislation regulates the scope of practice of professional forestry within the Province of Ontario
- **Clean Water Act (2006)** – Statutes of Ontario
    - **Purpose**: To protect the province's existing and future sources of drinking water.
- **Endangered Species Act (2007)** – Statutes of Ontario
    - **Purpose**: Among other things, the act is the province's legislative commitment to the protection of species at risk and their habitat

- **Details**: The project has had a Threatened and Endangered Species Evaluation performed by Geo-Source Inc. Environmental Consultants and has management guidelines for relevant species in the project area.

- **Managed Forest Tax Incentive Program (2012) –** Ontario Ministry of Natural Resources
  - **Purpose**: Landowners who get their property classified as "Managed Forest" pay 25% municipal residential property tax rate, by following a 10-year Managed Forest Plan, approved by a Managed Forest Plan Approver, and submit a 5-year progress report, update plan every 10 years to stay in the program

- **Forestry Act (1990) –** Revised Statutes of Ontario
  - **Purpose:** To establish programs to protect, manage or establish woodlands and to encourage forestry that is consistent with good forestry practices.

- **Municipal Act (2001) –** Statutes of Ontario
  - **Purpose**: The act gives municipalities broad powers to pass bylaws and govern within their jurisdiction. The act also outlines requirements for municipalities including practices and procedures. accountability and transparency.

Federal Laws, Statutes, and Regulations

- **Fisheries Act (1985) –** Revised Statutes of Canada
  - **Purpose:** The purpose of this Act is to provide a framework for the proper management and control of fisheries; and the conservation and protection of fish and fish habitat, including by preventing pollution

- **Migratory Birds Convention Act (1994) –** Statutes of Canada
  - **Purpose**: The purpose of this Act is to implement the Convention by protecting and conserving migratory birds — as populations and individual birds — and their nests.

- **Canadian Navigable Waters Act (1985) –** Revised Statutes of Canada
  - **Purpose**: The Canadian Navigable Waters Act regulates works and obstructions that risk interfering with navigation in navigable waters. It also prohibits the dumping of fill that risk impacting navigation in navigable waters and the dewatering of navigable waters.

Local Laws, Statutes and Regulations

There are no laws statutes and regulations pertaining to this private land.

Other Certifications and Registrations

- Sustainable Forestry Initiative (SFI)
  - **Purpose:** Promotes sustainable forestry based on 13 Principles, 17 Objectives, 41 Performance Measures and 114 Indicators. These requirements include measures to protect water quality, biodiversity, wildlife habitat, threatened and endangered species, and Forests with Exceptional Conservation Value. Private landowners that are certified to the SFI standards are expected to follow Best Management Practice guidelines outlined in the SFI: Best Management Practices for forest operations in northern Ontario and Manitoba for Private Landowners and Logging Contractors.
  - **Details**: The project area is to be certified to the Sustainable Forestry Initiative in Fall 2023,
- Forest Stewardship Council (FSC)
  - **Purpose:** FSC forest management certification confirms that the forest is being managed in a way that preserves biological diversity and benefits the lives of local people and workers, while ensuring it sustains economic viability.
  - **Details**: The land owners may pursue FSC certification for the property in future
- Ontario Professional Foresters Association
  - **Purpose:** An organization committed to actively contributing to sustainable forest management by assuring the highest professional standards of practice in forestry.
  - **Details:** The property is managed by a Registered Professional Forester (RPF) in Ontario, under this Association.

1.15 Participation under Other GHG Programs

1.15.1 Projects Registered (or seeking registration) under Other GHG Program(s)

The project is not registered, and is not seeking registration, under any other GHG program.

1.15.2 Projects Rejected by Other GHG Programs

The project has not been rejected by any other GHG program.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

The project does not reduce GHG emissions from activities that are included in an emissions trading program or any other mechanism that includes GHG allowance trading.

1.16.2 Other Forms of Environmental Credit

The project has not sought or received another form of GHG-related environmental credit, including renewable energy certificates. The project proponent may wish to pursue certification for the project under the VCS SD VISta or Climate, Community & Biodiversity (CCB) Standards in future. The project also intends to pursue novel approaches to crediting of biodiversity and water quality enhancement and protection outcomes, which has been factored into the business case for the land acquisition. The land is being certified for wood production under the Sustainable Forestry Initiative standard and may be certified to the Forest Stewardship Council standard in the future.

1.17 Sustainable Development Contributions

Table 3 identifies how the project is in alignment with the sustainable development activities outlined in the Canada's Federal Sustainable Development Strategy[6] (FSDS), under the Federal Sustainable Development Act (2008)[7]:

Table 3. Alignment of the project with Canada's Federal Sustainable Development Strategy.

FSDS Chapter #	FSDS Chapter Subject	Project Alignment with FSDS Chapter
4	Publicise research, knowledge and data for sustainable development	The project information is publicly available, offering significant information on the area and project site. Information is also provided publicly on the FRI, which is pioneering within the carbon space with regard to integration of remote sensing and advanced analytics.
6	Ensure clean and safe water for all Canadians	The logged-to-protected nature of the project will result in protected riparian zones, ensuring clean water bodies within the site.

[6] https://www.fsds-sfdd.ca/

[7] https://laws-lois.justice.gc.ca/eng/acts/F-8.6/page-1.html#h-240644

8	Encourage inclusive and sustainable economic growth in Canada	All entities involved in project development are Canadian-based, and the 100-year crediting period chosen for the project ensures a sustainable source of revenue for the Canadian-based project proponent.
9	Foster innovation and support green infrastructure in Canada	The project's inclusion of the innovative FRI is pioneering within the carbon space, and it is anticipated to set a precedent for future projects.
11	Improve access to transportation, parks, and green spaces, as well as support cultural heritage in Canada	The property's forest and watercourses are accessible and available for gentle recreational use by the general public, as well as culturally for local Indigenous groups. Also, the land was the focus of over 100 documented paintings by the iconic Group of Seven artists. PFLP is choosing to voluntarily integrate information on the historical painting sites into its management plans to foster stewardship and retention of these historical landmarks.
13	Take action on climate change and its impacts	The project generates carbon emission reductions; the prime purpose of which is to address climate change and its impacts.
15	Protect and recover species, conserve Canadian biodiversity	The logged-to-protected nature of this project will create new forests with old growth characteristics and preserves and improves upon existing habitats and its associated biodiversity, including the threatened and endangered species identified in Section 1.13. PFLP is also developing additional habitat management plans for the endangered wood turtle in consultation Canadian experts on the species. The Painted Forest is at the most northern extent of the wood turtles distribution in Canada and represents one of the most intact ecosystems for the species in the country.

1.18 Additional Information Relevant to the Project

Leakage Management

The market leakage factor is estimated to be 17.2% using the VM0012 Market Leakage Option 3 – Leakage Assessment Tool, in accordance with the methodology. Leakage is assessed from publicly available data from the forest wood products market, which is used to identify where leakage risk is most likely to be leaked to (or replaced from). This allows for a more detailed assessment of leakage (compared to other options) for its weighing into different biomass areas, and to separate domestic versus international leakage proportions. The leakage assessment is provided in Appendix A.

Commercially Sensitive Information

The primary contents of this publicly available project description document are not considered confidential. However, elements of reference materials and supporting source data are deemed confidential, including that of financial models, enhanced forest resource inventory (eFRI), and details of property acquisition. Any isolated areas of text that are deemed confidential are blacked out in the public version of this document and identified as confidential.

Further Information

No further relevant information.

2 SAFEGUARDS

2.1 No Net Harm

No negative environmental impacts are expected to result from the project. The overall natural ecosystem on the property is, however, expected to improve, with enhancements to biodiversity, watercourses and forest health.

Socio-economic impacts in the locality are overall expected to be positive.

- **Recreation**: The property is already utilised for outdoor recreational purposes, including hunting, trapping and fishing. The reduction in harvest implemented by the project will result in improved tranquillity on the property and improved recreational enjoyment as disturbance from new logging activity will be reduced and the forest ecosystem will become more representative of intact forests. Recreational activity that is compatible with PFLP's long-term management goals will continue to be available to the public.

Restrictions may be put in place related to access or activities (e.g., camp fires) during times of higher fire risk.

- **Employment**: The significant reduction in logging on the property will somewhat limit employment opportunities in harvesting. However, new employment opportunities are created through ongoing monitoring of the forest for project verification purposes, tree marking by certified tree markers for thinning and harvest activities (no tree marking was historically used), thinning of over-stocked and/or diseased trees (not conducted under previous management), and gathering of non-traditional forest products (e.g., chaga mushrooms). These additional activities are expected to compensate for the impact of reduced harvest rates on the property.

- **Health**: Access to the property by Indigenous peoples for traditional medicinal purposes is encouraged, and the benefits to overall forest ecosystem is anticipated to improve growth of these traditional medicines.

2.2 Local Stakeholder Consultation

The Painted Forest is an isolated, access controlled private property, and there are no stakeholders living on or reliant upon the project area for their well-being and, as such, there is no regulatory or formal requirement for stakeholder consultation.

However, the project proponent has communicated with the leaseholders on the property, who are users with access to the land, about the project via a letter. This letter serves to notify these users of the project's development, and explains the intentions of the carbon project in the change in land-practices and the resulting benefits to greenhouse gas emission levels and climate, as well as to biodiversity and forest health. Activities relating to the project were also communicated, including the field data collection on the property, the project development process, and the registration of the project on the VCS Registry. Information was also provided on the innovative nature of this carbon project, and on any changes to the property, i.e. reduced harvest activities, a continuation of regular road and culvert maintenance as well as less regular upgrades. Questions were invited via an email.

Other interested parties include the Indigenous communities identified in Section 1.13. The project proponent has initiated engagement with these communities and will continue throughout the lifespan of the project and encourage their use of the property.

Additionally, the Sault Ste. Marie Economic Development Office have been informed of the project with the intention of coordinating to improve economic opportunities in the Sault Ste. Marie region.

2.3 Environmental Impact

The project is not subject to any regulatory environmental impact assessments.

Furthermore, there are no known negative environmental impacts to assess for the project activity of retaining a forest. Positive environmental impacts, however, include enhancements to biodiversity, watercourses and forest health, by retaining the forest's natural ecosystem and undertaking strategic small-scale harvesting and thinning.

2.4 Public Comments

As explained in Section 2.2, due to the nature of the project being on controlled private property in Canada with no other stakeholders living on or reliant upon the project area for their well-being, and the project activity not involving any activities of disturbance to the area, stakeholder consultation has taken the form of an informative letter to leaseholders on the property, who are users with access to the land. A means of contact was provided for any questions, and the project scenario has remained unchanged.

2.5 AFOLU-Specific Safeguards

As the project is on controlled private property in Canada with no other stakeholders living on or reliant upon the project area for their well-being, and the project activity does not involve any activities of disturbance to the area, there are no stakeholders affected by the project.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

Table 4. Methodology and Tools applied.

Methodology	VM0012: Improved Forest Management in Temperate and Boreal Forests (LtPF), v1.2
Tools	VCS AFOLU Non-Permanence Risk Tool v 4.0
	VT 0001 Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry, and other Land Use Project Activities v.3.0

3.2 Applicability of Methodology

As shown in Table 5, the Painted Forest Carbon Project is compliant with the applicability criteria of VM0012.

Table 5. Applicability of the project to each applicability criteria identified in the VM0012 methodology.

Applicability Criteria	Painted Forest Project Applicability
Projects which meet the most recent approved criteria for VCS Improved Forest Management – Logged to Protected Forest (IFM-LtPF) eligible projects	The project meets the approved criteria for VCS IFM-LtPF (see Section 1.3)
Projects located in Temperate and Boreal Domain Global Ecological Zones (as defined by FAO (FAO, 2001)) which are forest lands remaining forest lands (as defined by IPCC (IPCC, 2003)), and which can meet IPCC GPG LULUCF Tier III inventory and data requirements (IPCC, 2003)	The project is located in the Temperate Ecological Zone. The project utilizes detailed site level inventory meeting Tier III criteria.
Projects that meet the most current approved VCS Standard requirements for ownership	The project area is located on a fee simple property which is privately owned by PFGP, the general partner of PFLP.
Projects on properties where the starting average annual illegal, unplanned, and fuelwood removals are less than 5% of total annual harvest levels (in CO2e) in the baseline scenario	The project involves no illegal or unplanned harvesting, and minimal fuelwood removals which are limited to branches and unmerchantable wood left at roadside.
Projects without managed peatland forests	The project area does not contain managed peatland forests.
Projects where % wetlands are not expected to change as part of project activities	The project will not materially change the % of wetlands in the project area
Projects that can demonstrate that no activity shifting leakage occurs to the proponent lands at the start of the project	PFLP can demonstrate that baseline activities are not being shifted to other areas as a result of the project. All of PFLP's lands are being developed as carbon projects.
Projects which do not include de minimis application of organic or inorganic fertilizers in the project scenario	The project does not include application of fertilizers in the project scenario.

3.3 Project Boundary

The project is spatially bounded by the parameters outlined in Figure 2 in Section 1.12 and Figure 3 below. The relevant GHG sources, sinks, and reservoirs within the project boundary are identified in Table 6, as well as the identification of emission sources in Table 7 that are either included or excluded from the project boundary

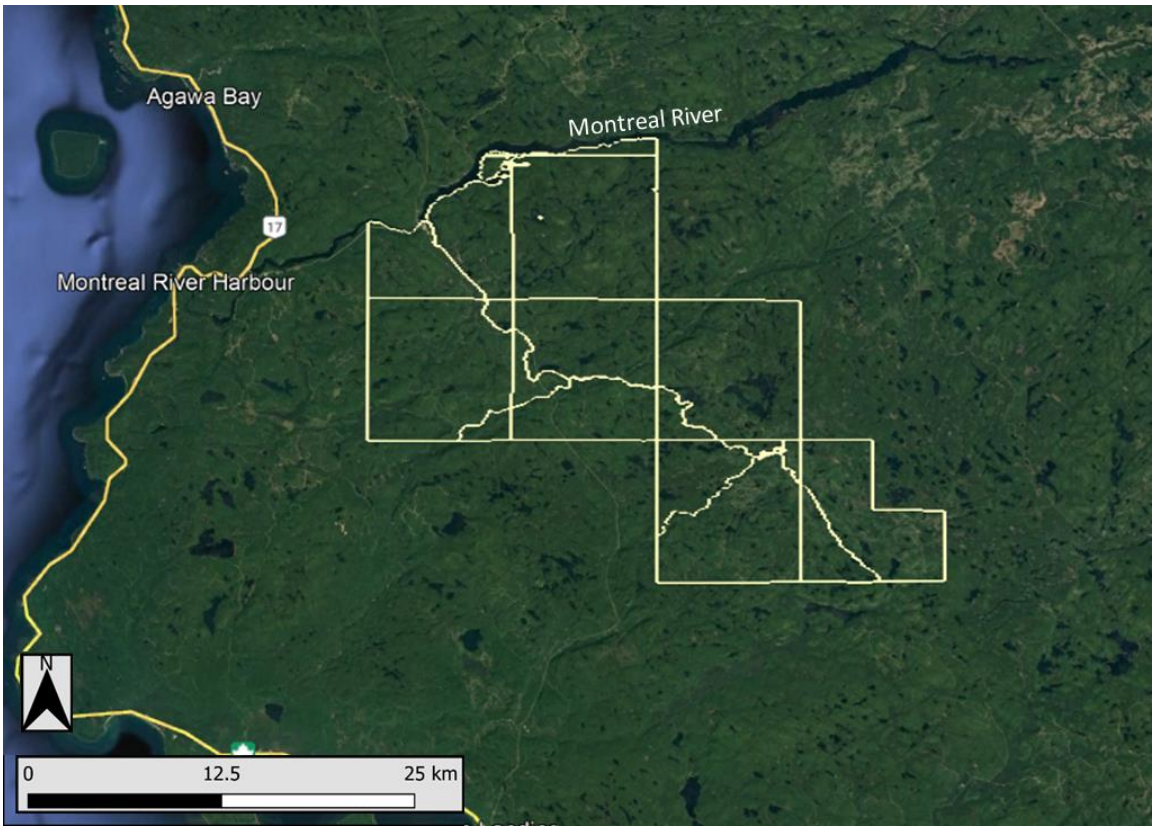


Figure 3. Project location and boundary, including the township boundaries. This project delineation has been provided to the VCS in KML format. Image Source: Google Earth.

Table 6. Selection of Carbon Pools.

Carbon Pool	Selected?	Justification/Explanation
Above-Ground Tree Biomass	Yes	Required by VCS. Major carbon pool subject to changes from the baseline to the project scenario.
Above-Ground Non-Tree Biomass	No	Excluded by VCS. Minor carbon pool subject to changes from the baseline to the project scenario.

Carbon Pool	Selected?	Justification/Explanation
Below-Ground Biomass Pool	Yes	Required by VCS. Major carbon pool subject to changes from the baseline to the project scenario.
Dead Wood Pool	Yes	Required by VCS. Minor carbon pool subject to changes from the baseline to the project scenario.
Litter Pool	No	Excluded by VCS for AFOLU projects. Minor carbon pool – generally considered as a transitional pool only.
Soil Carbon Pool	No	Optional in VCS AFOLU IFM projects, but excluded in this methodology. As a conservative approach, changes to soil carbon from harvesting are assumed to be *de minimis*.
Wood Products Pool	Yes	Required by VCS. Baseline scenario involves logging.

Table 7. Emission sources included/excluded from the project boundary.

Source	Gas	Included?	Justification/Explanation
Use of Fertilizers	CO_2	No	Neither the baseline nor project scenarios include the use of fertilizer, therefore these emission sources are excluded. The exclusion of these emissions do not increase the emission reductions in the project.
	CH_4	No	
	N_2O	No	
	Other	No	
Combustion of Fossil Fuels by Vehicles / Equipment	CO_2	No (Optional)	Carbon emissions from harvesting equipment, log transport, and primary forest product manufacturing are greater in the baseline scenario than the project scenario. The exclusion of these emissions do not increase the emission reductions in the project and is assumed to be negligible as a conservative approach.
	CH_4	No	
	N_2O	No	
	Other	No	
Burning of Biomass (on site slash burning)	CO_2	No	Neither the baseline nor project scenarios include burning of biomass as an activity, therefore these emission sources are excluded. The exclusion of these emissions do not increase emission reductions in the project.

3.4 Baseline Scenario

The VM0012 methodology outlines a 3-step procedure for determining the baseline scenario:

- STEP 1 – Identify Plausible Alternative Baseline Scenarios to the VCS Project Activity
- STEP 2 – Selection of a Single Baseline Scenario for the Project; either:
  - STEP 2a - The Historical Baseline Scenario – based on historical operating practices on the property
  - STEP 2b - The Common Practice Baseline Scenario – based on previous owner activities
  - STEP 2c - The Common Practice Baseline Scenario – based on common practice activities
- STEP 3 – Additionality Test.

STEP 1 - Identify Plausible Alternative Baseline Scenarios to the VCS Project Activity

Seven baseline scenarios are identified, and determined to be either plausible or not. They are documented as follows.

a) Increase in harvest rate relative to harvest activities prior to the project

This scenario involves an increase in harvest activity following acquisition by a timberland investor in order to optimize net present value.

The property contains well-stocked forest and has a history of timber management, making the option for timber investment financially feasible, as net income from timber management produces positive returns, as well as a recent increased familiarity with timberland investment has increased their demand. A private timberland investor or institutional investor would likely take these measures and use the property for timber production. It is therefore a plausible option.

b) Proceed with former landowner's forest management plan

The forest management practices scheduled by the previous owner are outlined in a Ten-Year Management Plan created for the property in 2014 and updated in 2020 (Appendix x). The goal is to manage the property in a way that yields the highest rate of return for its investors while maintaining and enhancing the biological productivity of the forest and, that when the management is terminated, the condition of the forestland affected is equal or superior than when it was acquired. The plan has divided the property into 5 compartments, with harvest timelines and quantity varying based on rate of recent and historical harvest, silvicultural maturity, road access, and markets, with plans regarding to future access and infrastructure needs.

Estimates provided in their 10-year plan suggest that the previous owners have cut less than growth for the property by 616,000 m^3 from 2014-2020. In all likelihood, harvest levels in 2021 may also have been low in this scenario due to the pandemic driven supply chain issues. A land appraisal report by a qualified forest land appraisal company which was commissioned prior to PFLP's purchase of the land suggested that the most likely scenario for a successful bidder on the land sale would involve a buyer that increases the cut over the next 10 years to capture the "undercut" timber, thereby enhancing financial returns. This assumes stocking per forested acre is drawn down to around 200 m^3/ha by year 10 of the holding period, and annual growth rate harvested thereafter. resulting in a temporary harvest increase of around 61,600 m^3 per year. This yields a harvest schedule of 168,443 m^3/year is implemented for the first 10 years and 106,975 m^3/year thereafter, based on the average rate of historical harvest on the property, with. This is a plausible option.

c) **Continued harvest based on common practice activities**

This scenario includes a harvest schedule of 151,297 m^3/year. This is based on the typical regional common practice of targeting merchantable timber through diameter limit and clear cut harvesting for private forestlands in Ontario and comparable regional silvicultural practices. It represents the annual harvest of forest-wide growth and is informed by the 2016 Ontario eFRI dataset[1] which is grown forward to end-2021. Harvest depletions from the eFRI issue date to end-2021 are accounted for. This is a plausible option.

d) **The project scenario, but without being registered as an IFM carbon project.**

This scenario considers a reduction to the current harvest practices on the property to protect the forest by 80%, without the incentive of carbon financing.

It is not plausible that conservation or avoided conversion of the forest would occur without carbon financing. This is because there is no history of conservation-oriented organisations in the area with sufficient funding or the intention to otherwise pursue acquisition of the property on their own and at this scale (and cost) without the financial incentive from carbon finance. Additionally, PFLP is not a not-for-profit organization, and they are seeking a return on their investment in this property.

e) **Logging of merchantable timber, followed by development.**

In this scenario, existing mature timber is harvested, with buffers maintained along watercourses to protect water and riparian values, as well as to maintain esthetic value for property buyers/lease holders.

Numerous leases already exist on the property for, commercial, storage, cabin, and industrial purposes and, most commonly, recreational purposes. Subdivision of the property into recreational lots, either for sale or lease, is therefore plausible.

f) **A combination of residential development and the continuation of historic forest management practices.**

In this scenario, recreational residential property development would be focused along the lakeside and river waterfronts, where demand is highest and existing lease properties are largely focused. Historical forest management practices would continue of the land of lesser residential value on the project property.

As there is a precedent for development on the property – in the form of existing leases (cabins, commercial storage, industrial, recreational) and one case of severance from the main landholding for a cottage– and well-established ongoing forest management practices, this is plausible option.

g) **Philanthropic giving of the property for conversion to conservation lands**

This scenario envisions philanthropic giving to, for example, a not-for-profit organization, local Indigenous communities, or the Ontario government, for the purpose of park creation or other conservation covenants on the land.

PFLP is a for-profit organization, and so they are seeking a return on their investment in this property; the same can be said of the previous owner, which was a timber investment management organization. Additionally, there was no expression of interest from other entities seeking to purchase the property in to carrying out this option. This is, therefore, not a plausible option.

STEP 2 – Selection of a Single Baseline Scenario for the Project

STEP 2a - The Historical Baseline Scenario – based on historical operating practices on the property

This step is mandatory in instances when the project proponent has at least 5 years historical harvest level data history on the property. The project proponent took ownership of the property in 2021, i.e. within the last 5 years, and therefore this step is not applicable to this project.

STEP 2b - The Common Practice Baseline Scenario – based on previous owner activities:

1. If the current project proponent has owned the property for less than five years then the project proponent may:

i. Choose to use the previous managers historical activities or management plan as representative of common practice, in which case the baseline scenario is selected based on the process and criteria in Step 2a; or,

ii. Choose to select the baseline scenario based on common practice and investment analysis of scenarios as outlined in Step 2c below.

The project proponent has not selected this option (Step 1 [b] for rationale) and, instead, opt for baseline based on common practice activities. See Step 2c below.

STEP 2c - The Common Practice Baseline Scenario – based on common practice activities:

For recent or pending changes in project property management without historical data (> 5 years) (or otherwise not selecting a historical baseline scenario as per Step 2b), the project proponent will select the baseline scenario(s)based on an assessment of regional common practice supported by a financial analysis for achieving typical market returns from forest products.

The project proponent must select the baseline scenario that:

2c.1 Generates the most financial attractive return on investment from forest product returns using the assessment process outlined in Step 2 Option II and/or Option III in the most recent version of the VCS Tool for the Demonstration and Assessment of Additionality in VCS AFOLU Project Activities; and,

2c.2 Can be demonstrated to be regionally common practice and locally operationally implementable, including:

a. Compliant with the legally required land use and forest management practices in a manner consistent with VCS requirements;

b. Consistent with local market capacity for the baseline scenario activities and products (i.e. log markets, contractor capacity, etc.);

c. Consistent with observable and verifiable regional operational practices, including, at minimum:

i. Harvest types (i.e. clearcut, selective cut, etc.),

ii. *Logging and hauling equipment types and capabilities,*

iii. *Annual harvest levels (i.e. m3/year, ha/year),*

iv. *Average minimum harvest age, tree size, and/or stand volume,*

v. *Average minimum economic viability (or decision criteria) by stand type,*

vi. *Average minimum log utilization specifications (on average based on size and/or species), and waste/breakage assumptions,*

vii. *Average tree retention practices, including hydro-riparian buffers, wildlife trees, and other single or grouped merchantable and un-merchantable tree retention,*

viii. *Maximum harvest slope or other operability constraints which would limit regional logging equipment,*

ix. *Reforestation and stand management practices; and*

d. *Operationally feasible on the project area using local harvesting and hauling technology, local infrastructure, etc.*

Project proponents must provide a description of the selected baseline scenario and related scenario modeling assumptions which justifies and provides supporting evidence that the baseline scenario selected under STEP 2c reflects a credible assessment of typical common practice for similar conditions, as listed above.

The chosen baseline scenario involves a harvest schedule of 151,297 m^3/year. This is based on the typical regional common practice of targeting merchantable timber through diameter limit and clear cut harvesting for private forestlands in Ontario and comparable regional silvicultural practices, and is informed by the current forest inventory on the property. It is compliant with the requirements outlined in this step 2c and in Section 3.5 in alignment with VT0001 Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities, v3.0[8].

This baseline scenario complies with Canadian and Ontario laws, statutes, and regulations. Land use regulations for private timber management in Ontario are minimal, with regulation confined to stream crossings at this time. Impacts of zoning and regulations on the property are minimal.

It is a comparable volume to the harvest activities of a previous landowner of this property (Appendix *) and of harvest activities on a neighbouring property, and is therefore demonstrably consistent with local market capacity.

It is consistent with observable and verifiable regional operational practices, including targeting merchantable timber through diameter limit and clear cut harvesting. Intolerant hardwoods and conifers are clear cut at merchantable (15-20 cm dbh) size. Tolerant hardwoods are partially cut

based on diameter limit (25-35 cm dbh) using selection, shelterwood and overstorey removal on 15 to 20 year intervals. Timber cruising and tree marking on private land in the region is not common and basal area is often not considered when making a decision to harvest a stand. Any riparian buffers, wildlife trees, and retention is incidental to harvest operability. Regeneration is natural and stocking surveys are not common after harvest.

Additionally, it is operationally feasible on property and its terrain, as demonstrated by similar harvesting practices by the previous landowner.

STEP3 – Additionality Test

See section 3.5.

3.5 Additionality

Additionality of the project is assessed via VT0001 Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities, v3.0[8]

Sub-step 1a. Identify credible alternative land use scenarios to the proposed VCS AFOLU project activity

Credible land use scenarios to the proposed project activity are listed below, and mirror those of the baseline scenarios. An additional scenario is included, i.e. the chosen project scenario as a carbon project.

a) Increase in harvest rate relative to harvest activities prior to the project
b) Proceed with former landowner's forest management plan
c) Continue to harvest based on regional common practice
d) The project scenario: i.e. 80% reduction in allowable harvest based on the baseline scenario, but without being registered as an IFM carbon project.
e) Logging of merchantable timber, followed by development.
f) A combination of residential development and the continuation of historic forest management practices.
g) Philanthropic giving of the property for conversion to conservation lands
h) The project scenario: i.e. 80% reduction in allowable harvest based on the baseline scneario, as a carbon project.

Those deemed plausible scenarios to occur on the land are scenarios a, b, c, d, e, f and h.

[8] https://verra.org/methodology/vt0001-tool-for-the-demonstration-and-assessment-of-additionality-in-vcs-agriculture-forestry-and-other-land-use-afolu-project-activities-v3-0/

Sub-step 1b. Consistency of credible land use scenarios with enforced mandatory applicable laws and regulations

All project scenarios identified are legally permissible to be undertaken on private property in Ontario.

Sub-step 1c. Selection of the baseline scenario

See Section 3.4, in line with VM0012. The chosen baseline scenario is "a common practice baseline scenario".

Step 2. Investment analysis

Sub-step 2a. Determine appropriate analysis method

As the VCS AFOLU project generates financial or economic benefits other than VCS related income from recreational and industrial leases. Since these revenues would occur under all of the baseline scenarios in equal amount, these revenues cancel out and therefore we apply the simple cost analysis.

Sub-step 2b. – Option I. Apply simple cost analysis

The operating costs of the project specific to the carbon itself are projected to be [redacted]/year (including costs of verification, issuance and registration, project management, monitoring, and sales costs)

The property was purchased through successful bid ($[redacted]), and a sale would have occurred irrespective of the ultimate land use. The cost of the land is a capital investment and does not factor into the operating cost of the project.

In addition, PFLP will also accumulate cost by undertaking property and conservation management activities such as road and water crossing maintenance, selective harvest and thinning activities, silvicultural prescriptions and tree marking, and administration of the above.

The project scenario includes room for periodic harvest as a part of conservation management.

The Painted Forest project only generates revenue through the sale of VCU's, timber harvesting to support forest health and generate minimal volume, and leases.

STEP 3: Barrier analysis

As Step 2: investment analysis was undertaken, this step is not required.

Step 4: Common Practice Analysis

Analysis of the extent to which similar activities have already diffused in the geographical area of the proposed VCS AFOLU project activity.

The Algoma Highlands Conservancy purchased 1,060 hectares of land in 2009 for $[redacted] through $[redacted] in private donations, $[redacted] from the Ontario Ministry of Natural Resources Greenlands Challenge program, $[redacted] from the EJLB Foundation, $[redacted] from the McLean Foundation, $[redacted] from the City of Sault Ste. Marie and $[redacted] from Chuck Peterson's bequeathment to the Algoma Highlands Conservancy. The conservation purchase aims to conserve the ecological integrity of the Algoma Highlands, facilitate low-impact recreational activities, conduct environmental research and enhance public awareness of the environment.

3.6 Methodology Deviations

The project applies a deviation to the VM0012 methodology by combining a field forest inventory, in accordance with VM0012, with a High Resolution Inventory Solution (HRIS), to create an enhanced forest resource inventory (eFRI) database. The deviation will not negatively impact the conservativeness of the quantification of GHG emission reductions or removals. The deviation relates only to the criteria and procedures for monitoring or measurement, and does not relate to any other part of the methodology. A full High Resolution Forest Inventory Methodology Report (Tesera, 2022) is provided to the verifier for audit purposes. Note, the name Montreal River Lands is used in place of Painted Forest within the report, but they refer to the same property with same spatial boundaries. The deviation is summarised throughout this section.

Deviation Overview

The project has developed a High Resolution Forest Inventory Solution (HRIS), over the treed portions of the Painted Forest Land area of interest, based on a data coverage area extending 100 m beyond the area of interest (Figure 2), for a total data coverage area of 61,726 ha. Note, only the final inventory within the project boundary is used for quantification of baseline and project carbon budgets.

The project team used an existing network of 629 ground plots (established in 2018) to inform the new stratification and determine the required number of new ground plots for the HRIS inventory. It was determined that a sample size of 125 new ground plots will be established and precisely geolocated to HRIS standards as part of the new inventory. The new ground sample plots were obtained by Northwinds Environmental Services in August-September 2022. Tesera Systems coordinated with the relevant project team members and contractors to ensure the plot data compilation meets the requirements of Ontario, CBM and HRIS, and the resulting inventory.

The project team use the following datasets to extrapolate a detailed forest inventory:

- the new ground plot compiled data;

- newly acquired remote sensed aerial laser scanning (LiDAR) and multispectral imagery (red, green, blue, near-infrared) imagery; and
- multispectral satellite imagery, in combination with cloud-computing geospatial analytics.

The project will demonstrate the reliability of producing structural attribute estimates for standing trees at the gridcell scale (20m x 20m) including diameters, heights and site index estimates at the microstand scale with polygons generally ranging from 0.2 to 5 ha in size. The previously established 629 plots will not be re-geolocated; however, they are recompiled (to a basic standard) for use by Tesera to QA/QC the new inventory.

Ultimately, the HRIS database product provides PFLP with the data attributes over the treed area that is required to support the carbon analysis and project development, planning and management activities to realise its stated goals over time and space.

HRIS Technical Methodology

The HRIS (High Resolution Inventory Services) is a two-step model and predict process. Target attributes are modelled to understand their representation across the project area. Formulas are then applied to the model to predict the target attributes.

Modeling:

- Ground sample data collected in ground sample units and remote-sensed land base coverage data is used;
- From the ground sample data, the desired target attributes for each ground sample unit are extracted;
- From the land base coverage data, features for each ground sample unit are computed;
- For each ground sample unit, the target attributes are combined with its features into a set of training data;
- Feature selection algorithms are run over the training data to find the most relevant features from which to learn; and
- Machine Learning is used to train models, to predict the target attributes based on the features.

Prediction:

- The land base is segmented into reporting units and further into analysis units of a similar size to the ground sample unit;
- From the land base coverage data, features for each analysis unit are computed;

- The derived models are applied to the features of each analysis unit to predict the target attributes; and
- The predicted target attributes are aggregated from the analysis unit to the reporting unit as inventory attributes.

Figure 4 illustrates the process flow of HRIS.

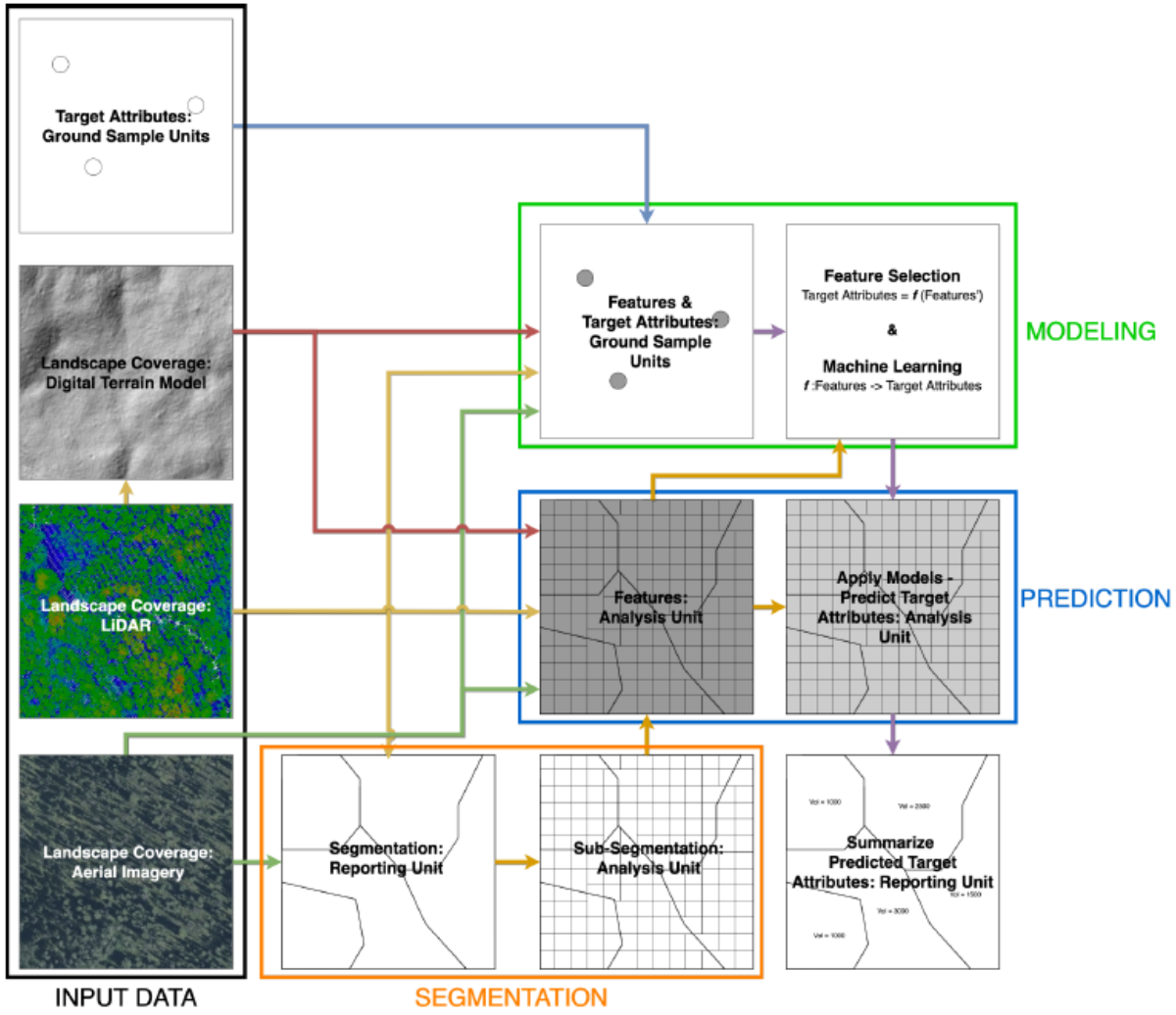


Figure 4. A process flow diagram of HRIS.

Terminology

This section outlines the definitions, using industry standard Machine Learning terminology 2. The sequence of the definitions below are as they appear and apply in the HRIS process:

Ground Sample Data: These are characteristics of physical objects, typically individual trees, that are measured and collected by domain experts:

- Species
- Diameter
- Height
- Live/Dead
- Volume calculations specific to species, based on taper equations, are compiled.

Ground Sample Unit: The spatial unit where ground sample data is collected – in this case, an accurately located circular polygon:

- Sample plot polygon: 10m in diameter (314 m^2)

Target Attributes: Aggregated values that are compiled from the ground sample data to the ground sample unit. These directly relate to your desired inventory attributes:

- Percent live/dead
- Basal area per hectare by species
- Mean diameter
- Dominant height
- Gross volume per hectare
- Land Base Coverage Data: Data that has been consistently captured (same sensor, resolution/density, geometry/angles and date-time) over the entire project area that logically explains the target attributes.
    - Aerial Imagery: imagery captured from an airborne craft, typically from a bird's eye view, in four bands (red, green, blue, near infrared). Imagery helps derive land cover, forest type, species and canopy cover.
    - Airborne Laser Scanning: commonly known as LiDAR (Light Detection and Ranging) is an active remote sensing technique used to record the surface and objects on the earth as a point cloud. LiDAR captures the full forest stratification from the main canopy through to the forest floor.

- Satellite Passive: satellite based imagery sensors gather radiation that is emitted or reflected by the object, reflected sunlight is the most common source of radiation captured as multi-spectral imagery (coastal, blue, green, red, red-edge, near infrared, short-wave infrared, narrow infrared, water vapour) depending on the product: Landsat, Sentinel-2, Planet.
- Satellite Active: satellite based sensors emit energy in order to scan objects, then measure the radiation that is reflected or backscattered from the target, typical products are: Sentinel-1 (Radar), GEDI (LiDAR).
- Ancillary: additional data that contributes positively or negatively to the prediction of the target attributes, including: historic climate, land use, depletions, constraints, and development.

- Features: Are characteristics calculated from the land base coverage data that relate directly or indirectly to the ground sample data and target attributes. Features are calculated for each ground sample unit and later each analysis unit.
  - Lidar features: height, structure, canopy
  - Imagery features: band reflectance, vegetation indexes
  - Topographic features: aspect, elevation, hydrology
  - Climate features: temperature, moisture, growing period
- Training data: Is the combined data set of target attributes and the features that have potential for explaining them.
- Feature Selection: Is the process of reducing the number of input variables when developing a predictive model to reduce the computation and improve the performance of the model. Statistical-based feature selection methods use statistical measures to score the correlation between each target attribute and the features and selecting those that demonstrate the strongest usefulness in predicting a particular attribute. Typically the number of features is reduced by over 95%.
- Modeling: Is the data science process of applying statistical analysis in a strategic manner to develop the mathematical relationships between one or more random variables and other non-random variables in a training dataset and then use those relationships to make predictions of the random variables. The target attributes are the random variables and the features are the non-random variables.

- Machine Learning: Is a branch of artificial intelligence (AI) which focuses on the use of training data and algorithms that it can use to reason over and learn from the data, gradually improving its accuracy.
- Model: A file that contains the result of training that can be used to recognize certain types of patterns. Once you have trained the model, you can use it to reason over data that it hasn't seen before, and make predictions about the data.
- Prediction: The application of a derived model to make a statistical inference of the target attributes based on the features calculated for each analysis unit. Every prediction has an associated probability that the predicted value is correct.
- Analysis Unit: The spatial areal unit of analysis that HRIS uses to develop an inventory. Typically a polygon of a similar size to the ground sample unit, ensuring that our training spatial unit and our prediction spatial unit are similar size, thereby minimizing the modified areal unit problem:
    - Hexagon (H3 resolution 12: 307 m^2)
- Reporting Unit: Is the spatial unit in which an inventory is delivered to a client, and is typically an aggregation of several analysis units:
    - Microstand (0.2 to 2 ha in size)
- Inventory Attributes: Your target attributes aggregated to the reporting unit.
    - Species percentage
    - Diameter by species
    - Height by species
    - Volume by species

Process for Creating an HRIS Inventory

A 10-step process is used to develop an HRIS inventory, as outlined below:

1. Target Attributes

The first step is to define and agree upon the target attributes list for the area of interest. Tesera and the project team work together to predetermine the target attributes (T) in the resulting HRIS inventory, the precision requirements of the attribute values, and the accuracy requirements of the attribute values.

At the outset, it is important to set the "project goalposts" by defining and agreeing upon the target attributes for the area of interest. The Painted Forest project team has predetermined which target attributes are required for the resulting HRIS inventory to meet the Project Goals (Table 8). Additionally, Tesera incorporate biomass attributes into the inventory data as required, calculated by Ostrom Climate Solutions Inc.

Table 8. List of Core Inventory Attributes

Name	Abbreviation	HRIS Attribute	Definition (source)
Reporting Unit Id	UID	sptl_micro_uuid	Globally unique identifier of the reporting unit (HRIS)
Area	AREA	sptl_micro_areamj	Area of the reporting unit [ha] (HRIS)
Elevation	ELEV	sptl_micro_dtm_el	Mean ground elevation of the reporting unit [m] (HRIS)
Aspect Slope	SLP	sptl_micro_asp_slp	Aspects mean slope of the reporting unit [degrees] (HRIS)
Aspect Direction	DIR	sptl_micro_asp_dir	Aspects mean direction of the reporting unit [degrees] (HRIS)
Inventory Date	INV_DATE	meta_inv_pub_date	Date of publication for the inventory (HRIS)
Inventory Version	INV_VER	meta_inv_ver_num	Version number for the inventory (HRIS)
Inventory Source Data	SOURCE	meta_inv_src_ref	Source reference data for the inventory (FRI)
Inventory Source Year	YRSOURCE	meta_inv_src_ref_yr	Year of the source reference data for the inventory (FRI)
Land Cover Class	POLYTYPE	pred_lcc_c1	Land cover class (FRI)
Forest Type	FTYPE	pred_spc_ftype	Forest type (Coniferous/Deciduous/Mixed) of the reporting unit (HRIS)
Trees Per Hectare	TPH	pred_tph	Trees per hectare in the reporting unit (HRIS)
Percent, Live	PCT_L	pred_spc_liv_pct	Percentage of basal area in the reporting unit, of live trees (HRIS)
Percent, Dead	PCT_D	pred_spc_ded_pct	Percentage of basal area in the reporting unit, of dead trees (HRIS)
Species Class N	SPC_Sn	pred_spc_sN_desc	Name of the species class N (HRIS)
Species Class N Percent	SPC_Sn_PCT	pred_spc_sN_pct	Percentage of basal area in the reporting unit, in species class N (HRIS)
Nth Leading Species	SPC_nL	pred_spc_Nld_ovr_desc	Name of the Nth leading species in the reporting unit (HRIS)
Nth Leading Percent	SPC_nL_PCT	pred_spc_Nld_ovr_pct	Percentage of basal area of the Nth leading species in the reporting unit (HRIS)
Diameter	DIA	pred_dia	Mean diameter at breast height (1.3 m) in the reporting unit [cm] (HRIS)
Overstorey Composition	OSPCOMP	pred_spc_ovr_lbl	Species composition of the overstorey (FRI): requires SPC_nL
Overstorey Leading	OLEADSPC	pred_spc_1ld_ovr_desc	Leading species in of the overstorey (FRI): requires SPC_1L
Overstorey Age	OAGE	pred_age_ovr	Age of the overstorey in the reporting unit [yr] (FRI)
Overstorey Height	OHT	pred_ht_ovr	Mean height of the overstorey in the reporting unit [m] (FRI)
Overstorey Closure	OCCLO	pred_cncvr_ovr_pct	Percentage of canopy cover of the overstorey in the reporting unit (FRI)
Overstorey Site Index	OSI	pred_si_ovr	Site index of the overstorey in the reporting unit [m] (FRI)
Understorey Composition	USPCOMP	pred_spc_udr_lbl	Species composition of the understorey (FRI): requires SPC_nL
Understorey Leading	ULEADSPC	pred_spc_1ld_udr_desc	Leading species in of the understorey (FRI): requires SPC_1L
Understorey Age	UAGE	pred_age_udr	Age of the understorey in the reporting unit [yr] (FRI)
Understorey Closure	UCCLO	pred_cncvr_udr_pct	Percentage of canopy cover of the understorey in the reporting unit (FRI)
Understorey Site Index	USI	pred_si_udr	Site index of the understorey in the reporting unit [m] (FRI)
Vertical Structure	VERT	pred_cncvr_c1	Distinct stories in the stand canopy in the reporting unit (FRI)
Horizontal Structure	HORIZ	pred_cncvr_c2	Class of canopy structure of the leading species in the reporting unit (FRI)
Gross Volume	GVOL	pred_volgph	Gross volume in the reporting unit [m^3/ha] (HRIS)
Gross Volume by L/D	GVOL_L/D	pred_volgph_liv/ded	Gross volume in the reporting unit, of live/dead trees [m^3/ha] (HRIS)
Gross Volume by Species	GVOL_Sn	pred_volgph_sN	Gross volume in the reporting unit, in species class N [m^3/ha] (HRIS)
Merchantable Volume	MVOL	pred_volmph	Merchantable volume in the reporting unit [m^3/ha] (HRIS)

2. Base Data Acquisition

After setting the goalposts, the next important step of the HRIS process is gathering the base data. Ground sample data is collected to cover the range of variation and locations are established within the area of interest. Remote-sensed land base coverage data is also acquired for the area of interest according to the HRIS specifications. The project team provides the following:

- The Ground sample data (GS) to the HRIS specs.
- Remotely sensed land base coverage data (lc) to the HRIS specifications.
- The required ancillary data (ad) (e.g. disturbance, cover, use, soil).

QA/QC is run on the land base coverage data versus the standards. For this project, Tesera utilize the existing 629 Algoma Final CFI ground sample plots for stratifying the land base and designing a new sample plot plan for approximately 125 plots that cover the range of variation in species and forest structure over the project area for precise GPS positioning and plot resampling. The plot centers are collected (and shared with Tesera) to a positional accuracy of +/- 0.5m according to HRIS specifications, and include:

- The Ontario Ministry of Natural Resources and Forestry, Science and Research Branch, Vegetation Sampling Network Protocol - Technical Specifications for Field Plots - Version 2 2021 Technical Manual TM-10) will be used as a guide for the plot sampling;
- Sufficient ground plot GPS location data and statistics to ensure positional accuracy;
- Summarized ground plot location data in digital format;
- A sample of the GPS location data, after the first few (one or two) weeks of data collection.

Remote sensing land base coverage data (simultaneously collected LiDAR and 4-band aerial imagery) is provided by KBM Resources Group.

3. Sample Plot Target Attribute & Feature Processing

The ground sample data is compiled to produce the target attributes and the land base coverage data is compiled into features for each ground sample unit. Features are calculated using R and Python scripts developed with open source libraries (raster, lidR, GRASS, rLiDAR, rgdal), then run at scale with our HRIS Runner (using AWS Elastic Compute).

- The target attribute (T) data for the ground sample units: T[GS] is compiled.

- The LiDAR and CIR data are fused and features (height, intensity, density, reflectance, spectral, texture and vegetation index) are calculated for each ground sample unit: Flc[GS].
- The terrain features (slope positions, and slope-aspect-elevation interaction affecting both species distributions and site productivity) are calculated for each ground sample unit: Flc[GS].
- The climate features (seasonal and annual growing degree days, moisture, and temperature) are calculated for each ground sample unit: Flc[GS].
- Ancillary data features may also be derived for each ground sample unit: Fad[GS].
- The resulting dataset combines 2500+ features and the target attributes as the training dataset: Flc[GS], Fad[GS].

The ground sample and plot level data is compiled by the project team, and Tesera then produces the target attributes of interest. In Step 3 Tesera derive features for each ground sample unit from the land base coverage data.

- The ground sample treelist data will be QA'd by Registered Professional Foresters (RPFs) within the project team;
- The project team apply appropriate equations to derive age, volume, live/dead, canopy top & bottom height, and canopy area for each ground sample treelist record;
- The project team compile the ground sample data to the plot level to cover all the target attributes listed in step 1;
- The project team provide the treelist, with calculated volumes, basal area and canopy cover, and compiled plot data with the required attributes in digital format;
- In addition to the 125 new sample plots, the project team similarly compile the plot data for the 629 existing plots.

4. Feature Selection

Data transformation and feature selection routines are applied to the training data to extract the best subset of features for predicting any one or more target attributes. Statistical-based feature selection methods involve evaluating the relationship between each target variable and each feature, and selecting the 20-50 features that have the strongest relationship with the target variable.

- Data transformations (normalization, redistribution and bin based encoding) are performed on the training data. For example, normalization methods such as MinMaxscaler are used to normalize the feature set in the range 0 to 1.
- A subset of the features that are indicative of the most significant relationship in predicting the target attributes, are selected using automated variable selection routines: T[GS] = f(Flc'[GS], Fad'[GS]). For example: RFE (recursive feature elimination) algorithm known for best features selection via pruning mechanisms is used with a combination of hyper-parameters which has a distinctive advantage over other feature selection algorithms. Combinations of RFE with other routines are also tested (e.g., feature importance-based Random Forest, XGBoost and others to yield best features).
- Based on the nature or distribution of the target attributes, an enhanced feature selection process adapted using automated variable selection routines T[GS] = f(Flc'[GS], Fad'[GS]). For example: feature selection of attributes like height, diameter, basal areas are selected using Bayesian Ridge based linear regression estimator on top of the RFE algorithm which can be used to include regularization parameters in the estimation procedure i.e the regularization parameter (techniques that are used to calibrate machine learning models in order to minimize the adjusted loss function and prevent overfitting or underfitting) is not set in a hard sense but tuned to the data at hand. Hence, this kind of approach is adaptive to various distributions of datasets.
- Statistical outputs on the relationships between the target attributes and the most significant features are developed.

5. Machine Learning

Data transformations including normalization and scaling are then applied to make the dataset ready for machine learning based models. Analytics/machine learning techniques, including k-nearest neighbour, linear regression, random forest, support vector machine, neural networks and XG boost are then deployed to estimate the target attributes of interest, as functions of the selected features, using the training data.

- The training data is separated into three parts:
    - Training Dataset: is used to fit the model.
    - Validation Dataset: is used to evaluate the fit of a model while tuning the model hyperparameters.

- Test Dataset: is used to provide an unbiased evaluation of a final model fit on the training dataset.

- Different learner algorithms are utilized depending on the target attribute.
- K-fold cross validation is used as part of our model-validation process.
- The result is a series of models that predict each target attribute as a function of the features: T = f(Flc', Fad').
- Statistical hypothesis testing, or significance tests, are run to interpret or quantify the significance, and confidence, in the resultant models.
- Coefficients of determination or R squared (R2) values are calculated for each model to evaluate the performance of each regression-based machine learning model, by calculating the amount of variance between the ground sample unit training target attributes and the model ground sample unit predicted target attributes.
- Confusion matrix plots are generated for each class within the target attribute to evaluate the number of misclassified ground sample units.
- Hierarchical modeling is applied based on the rank/scale of the target attribute: class & sub-class.

6. Area Segmentation (reporting & Analysis Units)

During Step 6, the entire area of interest is segmented into land base elements by a process developed in GRASS GIS. The segmentation process generates reporting units of approximately 0.2 to 2 ha that delineate physical land base objects and forest patches of similar structure/type. Reporting units are further sub-segmented into analysis units (AU), of a similar size to the plot, to resolve any modifiable areal unit problems (MAUP).

7. Segment Feature Data Processing

In Step 7, the remote-sensed data is compiled into features for each analysis unit.

- The LiDAR and CIR data are fused and features (height, intensity, density, reflectance, spectral, texture and vegetation index) are calculated for each analysis unit: Flc'[AU]
- The terrain features (slope positions, and slope-aspect-elevation interaction affecting both species distributions and site productivity) are calculated for each analysis unit: Flc'[AU]

- The climate features (seasonal and annual growing degree days, drought indices, and temperature) are calculated for each analysis unit: Flc'[AU]
- Ancillary data features may also be derived for each analysis unit: Fad'[GS]
- The resulting dataset contains the sub-set of features that were determined to be significant through the feature selection process: Flc'[AU], Fad'[AU].

8. Target Attribute Prediction

- The derived models are applied to each analysis unit to estimate the target attributes across the area of interest.
- The ML models are applied to predict each target attribute for each treed analysis units as a function of the features: T[AU] = f(Flc'[AU], Fad'[AU]).

9. Compile and QA Inventory Attributes

The resulting predicted analysis units with target attributes are compiled and run through a comprehensive QA process:

- Required data transformations are applied to the predicted target attributes.
- A QA process is performed on the resulting target attributes to ensure the values are within the range of variation of the sample plot data and are consistent with each other.
- Accuracies are derived for each analysis unit based on a nearest neighbour calculation to the most similar ground sample unit.
- The nearest neighbour R squared and distance are used to derive the overall predicted accuracy for each analysis unit and each attribute predicted accuracy. We currently generate coefficient of determination (R squared) values [how accurate the model is measured vs predicted] versus the alternative of root mean squared error (RMSE) values [the error between the measured and predicted]. RMSE values can be generated if required.

10. Summary and Reporting

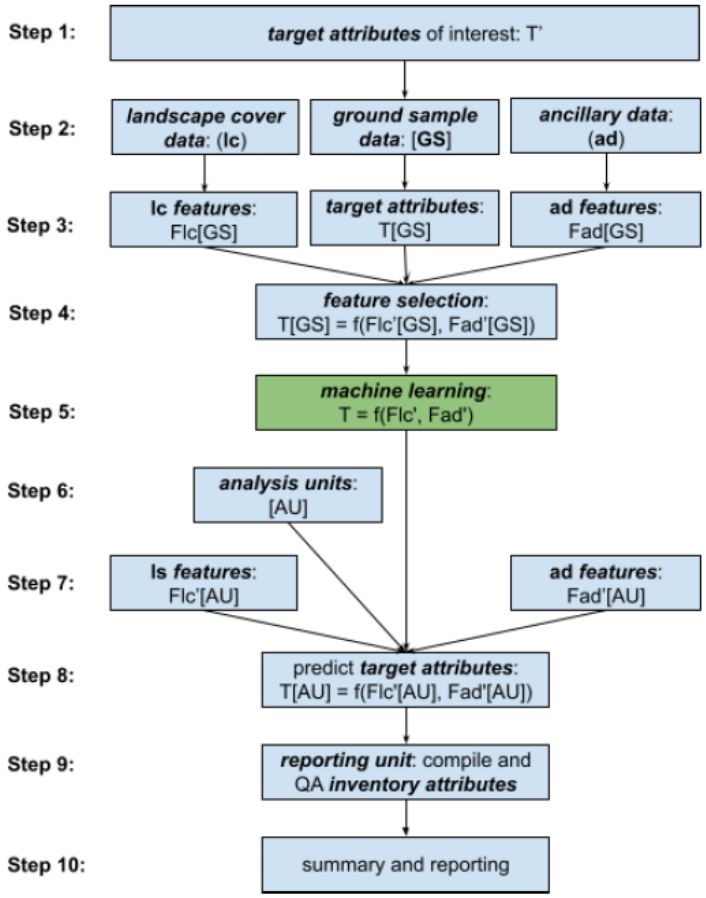
- The sub-segment target attributes are aggregated to the reporting unit as inventory attributes and an inventory summary and quality report is developed:

- The sub-segment target attributes and accuracies are run through an aggregation process to summarize the target attributes for each reporting unit as inventory attributes.
- The inventory attributes are reviewed for completeness.
- Using the raw data QA, areas of interest are identified that are lacking in confidence and could potentially be targeted for improved data collection or additional ground sampling.
- The following is reported on: raw data QA, sample plot processing decisions, segmentation development, target inventory QA, and the levels of realized precision and accuracy (bias) for each attribute.

The HRIS inventory is provided in geo-package format, and includes the target attributes identified in Step 1 and derived QA attributes.

- All data and supporting documentation provided by Tesera is in digital format, uploaded to an AWS S3 bucket (provided by Tesera).
- A quality control / quality assurance report is developed by Tesera.
- A final inventory summary is developed by Tesera.

Figure 5 illustrates the flow of data of HRIS.



'T' = target attributes
'GS' = ground sample data that has been measured
'T[GS]' = compiled target attributes.
'AU' = a segmented analysis unit of similar aerial unit size to the ground sample unit that is contiguous across the entire land base.
Features = individual variables that are used for training the model and predicting each target attribute
'lc' = land base coverage data
'ad' – ancillary data
'Flc[GS]' = derived from features derives from the land base coverage data
'Fad[GS]' = derived from ancillary data for the ground sample units for training the model
'Flc[AU]' = features derived from the land base coverage data
'Fad[AU]' = features derived from ancillary data for the analysis units for predicting the target attributes of interest
'T[AU]' = predicted target attributes on the analysis unit.

Figure 5. A data flow diagram of HRIS.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

The project is based on a valid starting forest inventory prepared by Tesera Systems Ltd specifically for the project. The design and production of the forest inventory was supervised by Mark Balogh RPF, a forester with knowledge and experience of forest inventories in Ontario mixedwood forests. Inventory data was collected in the summer of 2022 using a combination of traditional field plots (a network of 128 permanent sample plots) and aerial LiDAR and 4 Band Imagery. Fieldwork was completed by NorthWinds Environmental Services and LiDAR and 4 Band capture was completed by KBM Resource Management. The inventory attributes of stand age class and site index were sourced from the Ontario Forest Resource Inventory and then validated and incorporated into the Tesera project inventory. The Tesera forest inventory provides forest attribute resolution at a finer scale than traditional plot-only inventories. Most importantly LiDAR data allows direct quantification of single tree heights and canopy structures across the entirety of the project area (aka wall-to-wall data). The Tesera HRIS results in a “wall-to-wall” inventory of the forest at a resolution of 0.2 to 2 ha, a much more granular inventory than is possible through any practical ground plot campaign.

The project used Ontario's Modelling and Inventory Support Tool (MIST) to generate growth and yield curves for the project area. MIST is a standard tool used to model growth for forest management and is developed and validated by the Modelling and Analysis Unit in Ontario’s Ministry of Natural Resources. The Carbon Budget Model of the Canadian Forest Service (CBM-CFS3) was then used to model the carbon dynamics of the project area. MIST and CBM-CFS3 meet all the criteria in Section 8.1.1 of the VM0012 methodology.

4.1 Baseline Emissions

As described in Section 3.4, the project will use “Step 2c: The Common Practice Baseline Scenario – based on common practice activities”. The resultant baseline harvest schedule is an Allowable Annual Cut of 151,297 m3/year. This is based on the typical regional common practice of targeting merchantable timber through diameter limit and clear cuttingfor private forestlands in Ontario and comparable regional silvicultural practices, and is informed by the Ontario eFRI (2016).

Valid Starting Inventory Requirements

A valid starting inventory was commissioned by PFLP in 2022. Tesera Systems was contracted to create the starting project forest inventory from field data (permanent sample plots) collected in summer 2022 by Northwinds Environmental and airborne LiDAR and 4 Band Imagery data collected by KBM Resources Group in 2022. The project meets the valid starting inventory requirements from VM0012:

- The inventory covers the entire project area.
- A new forest inventory was created in 2022 from data collected in 2022.
- Documentation on all inventory methods are available in the Tesera methodology document and ancillary supporting documents, listed in Appendix 1.

The inclusion of LiDAR data, and associated analysis, enables a more detailed forest inventory than would be possible by field measurements alone. Indeed, the intensity of field sampling done in 2022 on the Painted Forest property would be enough to satisfy the statistical requirements for a purely field-based inventory under VM0012 methodology, but the owners of the property opted to also include LiDAR data capture and analysis with the vision of advancing enhanced LiDAR forest inventories as part of their greater organisational strategy.

The 2022 Painted Forest inventory is housed with PFLP's and Ostrom's file servers as a spatial database. The inventory spatial database is comprised of microstand level polygons with detailed attributes including: tree count, tree species, tree height, tree diameter.

Future project inventory updates will be completed using a combination of field-based re-measurement of permanent sample post and updated LiDAR data capture and analysis.

Baseline Scenario Area Stratification

Step 1 – Area stratification

The 2022 forest inventory for the property is stratified by age class and forest type. The forest types are defined in the MIST growth and yield model. Age class data was obtained from the most recent provincial FRI inventory and was validated and calibrated using tree core data taken during the 2022 field measurement campaign.

Step 2 – Identify areas eligible for specific management activities

The portion of the property that contributes carbon stocks and that are subject to scenario management activities (the *netdown* area) were informed using the operability parameters from the *Quercus ten-year management plan (2014),* including forest type, stand age, stand volume, riparian buffers and terrain operability constraints. 2022 LiDAR data was used to refine the terrain constraints (e.g. steep slopes and rocky areas) that inform the project scenario. 2022 forest inventory data was used to validate and refine the netdown area according to the following parameters:

1. Steep slopes (>45% slope)
2. Site Index / non-productive (<XX Site Index)
3. FRI non-forest FUs (non-forested areas)

Non-forest and road and rail right-of-ways are assumed to have no carbon stocks for the purpose of the project. Roads are defined with a width of 4.5 m and the rail right-of way is excluded from the project area. A dataset containing an inventory of known roads in the area was sourced from public data with edits and additions from the previous property owner.

Within the netdown area carbon stocks are modelled for each year of the project using CBM for both baseline and project scenarios.

Model Selection and Use

The Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) was selected to model carbon stock changes over time for both the baseline and project scenarios. Development of the first version of the first Carbon Budget Model began in 1989, and development of the CBM-CFS3 in 2001 and has been under continuous use and development with the latest update being in 2021. Additionally, CBM-CFS3 has been calibrated for all ecological boundaries of Canada, including Ontario's ecological boundaries of Boreal Shield East, Boreal Shield West, Hudson Plains, and Mixedwood Plains (the Project Area lies within the Boreal Shield East ecological boundary of Ontario). CBM-CFS3 is an aspatial, stand- and landscape-level modelling framework used for modelling various carbon pools on an annual basis. CBM-CFS3 meets the following suitability criteria in accordance with the methodology:

1. Well established (i.e., have been under continuous use and development for 10 years or longer).
2. Generate values on an annual basis, or at intervals not exceeding 10 years.

3. Include a reasonable representation of mortality from stand-self thinning and natural disturbance agents that are regionally appropriate. Adjustments may need to be made by to account for these factors if they are not well represented. Rationale will be provided when making adjustments.

4. Output data are expressed in carbon units (tC) and are calculated for each of the required carbon pools (See Table X). Expansion factors are used in combination with growth and yield model(s), and are based upon regionally specific studies and applied only for the appropriate region and species.

5. Well documented and expert reviewed. These include (a) ongoing publications in peer-reviewed scientific journals, (b) documented reviews by expert practitioners in forestry/biology/ecology, and (c) approved by government for use in forest management activities.

6. Parameterized, calibrated, and tested for the specific conditions of the project.

7. Documented as appropriate for simulating the ecological and management scenarios that define the baseline and project case.

8. Is a model that simulates carbon dynamics directly at the stand-level and in the case of landscape models (i.e. forest estate models), be driven by inputs from the stand level.

9. Requires input from a growth and yield model commonly used to project productivity in managed and unmanaged forest stands.

MIST was selected for growth and yield modelling because it is well established (development began in 2008 and has been continuously used and developed with 2022 being the latest update), generates values at 5 year increments, well documented and expert reviewed, parameterized, calibrated and tested for Ontario's Boreal and Great Lakes-St. Lawrence forest zones (the Project Area lies within the Great Lakes-St. Lawrence forest zone), and is documented as appropriate for simulating growth and yield of the ecological and management scenarios that define the baseline and project case.

The forest inventory provides data on species composition, site index, stems per hectare, age and area of each stand within the Project Area.

The species composition, site index, and stems per hectare of each stand from the forest inventory are input into MIST to model growth and yield in 5-year increments from 0 to 120 years of age. The output units are in merchantable volumes per hectare (m^3/ha).

The leading species, age and area of each stand from the forest inventory, along with corresponding growth curves from MIST, are input into CBM-CFS3 to model carbon stocks and changes on an annual basis. The output units are in tons of carbon (tC).

Calculating the Baseline Carbon Balance

The total annual carbon balance in year t for the baseline scenario (ΔCBSL,t) is calculated using Equation 1 of VM0012, which is equal to the annual change in carbon stocks in all pools in the baseline across the project activity area.

The annual change in carbon stocks in all pools in the baseline across the project activity area (ΔCBSL,P,t) is calculated using Equation 2, which is made up of the annual change in carbon stocks in above- and belowground living tree biomass (ΔCBSL,LB,t), dead organic matter (ΔCBSL,DOM,t), and harvest wood products (ΔCBSI,HWP,t).

The annual change in carbon stocks in living tree biomass (above- and belowground) (ΔCBSL,LB,t) is calculated using Equation 3 by accounting for live biomass gain (ΔCBSL,G,t) and live biomass loss (ΔCBSL,L,t); however, this equation is not applicable because the outputs of the CBM-CFS3 model for carbon stocks in living tree biomass (above- and belowground) already accounts for live biomass gain and loss (see Live Biomass Gain and Live Biomass Loss sections below).

Live Biomass Gain

The annual increase in tree carbon stock from growth (ΔCBSL,G,t) is defined by Equation 4; however the function of this equation is already integrated within the CBM-CFS3 modelling. Instead of utilizing the annual increment rate in tree biomass (tdm/ha/yr), (GBSL,i,t) and applying the carbon fraction of dry matter tC/tdm (CF), for each area (ha) of forest land (ABSL,i); the model utilizes the merchantable growth and yield curve and applies integrated species- and region-specific expansion factors to estimate tons of carbon that would have been gained from forest growth. This is in accordance with VM0012 in utilizing growth and yield models where output is in the form of an annual merchantable timber volume and converted using a series of expansion factors representing each carbon pool.

In relation to Equation 4, Equation 5a (which inputs into Equation 4) is not necessary. Equation 5a defines the annual increment rate in tree biomass (tdm/ha/yr), (GBSL,i,t) as the sum of the annual above- and belowground biomass increment rates in tdm/yr (GBSL,AG,i,t and GBSL,BG,i,t, respectively). The CBM-CFS3 model utilizes the merchantable growth and yield curve and applies

integrated species- and region-specific expansion factors to estimate tons of carbon that would have been gained from forest growth in the aboveground carbon pool.

Equation 5b (which input into Equation 5a) defines the annual belowground biomass increment rates (GBSL,BG,i,t) as equal to the application of the root:shoot ratio (Ri) applied to the aboveground rate. Equations 5b is not necessary because CBM-CFS3 applies integrated species- and region-specific root:shoot ratios to estimate forest growth in the belowground carbon pool.

Therefore, Equations 4, 5a, and 5b are unnecessary as CBM-CFS3 accounts for live biomass gain within the model for the live biomass carbon pool output.

Live Biomass Loss

The annual decrease in live biomass tree carbon from live biomass loss ($\Delta C_{BSL,L,t}$) is defined by Equation 6 as the summation of the annual loss of live tree biomass due to natural mortality, commercial felling, and from incidental sources ($L_{BLBSL,NATURAL,i,t}$, $L_{BLBSL,FELLINGS,i,t}$, and $L_{BLBSL,OTHER,i,t}$, respectively, calculated by Equations 7, 8, and 9, respectively), with the application of the carbon fraction (CF); however, the function of this equation is already integrated within the CBM-CFS3 modelling (below).

Equation 7 calculates annual loss of live tree biomass due to natural mortality ($L_{BLBSL,NATURAL,i,t}$) by applying the annual proportion of biomass that dies from natural mortality ($f_{BSL,NATURAL,i,t}$) to the average live tree biomass (tdm/ha) ($L_{BBSL,i,t}$) for each area (ha) of forest land ($A_{BSL,i}$). The annual proportion of biomass that dies from natural mortality is integrated into CBM-CFS3 with species- and region-specific parameters (or natural carbon transfers), and the live biomass of each stand is already calculated in tons of carbon each year by the model.

Equation 8 calculates annual loss of live tree biomass due to commercial felling ($L_{BLBSL,FELLINGS,i,t}$) by applying the proportion of biomass removed by harvesting from polygon to the average live tree biomass (tdm/ha) ($L_{BBSL,i,t}$) for each area (ha) of forest land ($A_{BSL,i}$). The proportion of biomass removed by harvesting from polygon is integrated into CBM-CFS3 with management-specific harvesting regimes and silvicultural regimes (or disturbances), and the live biomass of each stand is already calculated in tons of carbon each year by the model.

Equation 9 calculates annual loss of live tree biomass from incidental sources ($L_{BLBSL,OTHER}$) by applying the proportion of additional biomass removed for road and landing construction ($f_{BSL,DAMAGE,i,t}$) to the average live tree biomass (tdm/ha) ($L_{BBSL,i,t}$) for each area (ha) of forest land ($A_{BSL,i}$). The proportion of biomass removed for infrastructure, such as roads and

temporary landings, is integrated into CBM-CFS3 with management-specific road and landing impacts (or disturbances), and the live biomass of each stand is already calculated in tons of carbon each year by the model.

Therefore, Equations 6, 7, 8, and 9 are unnecessary as CBM-CFS3 accounts for live biomass loss within the model for the live biomass carbon pool output.

Dead Organic Matter Dynamics

The annual change in carbon stocks in DOM ($\Delta C_{BSL,DOM,t}$) is calculated by Equation 10 as the summation of change in lying dead wood (LDW), snag, and dead belowground biomass carbon stocks ($\Delta C_{BSL,LDW,t}$, $\Delta C_{BSL,SNAG,t}$, and $\Delta C_{BSL,DBG,t}$, respectively).

Change in Lying Dead Wood (LDW) Carbon Stocks

The change in lying dead wood (LDW) carbon stocks ($\Delta C_{BSL,LDW,t}$) is defined by Equations 11a and 11b, which applies the carbon fraction (CF) to the annual increase and decrease in LDW biomass ($LDW_{BSL,IN,i,t}$, and $LDW_{BSL,OUT,i,t}$, respectively) to the total mass of lying dead wood accumulated ($LDW_{BSL,i,t}$). However, the function of these equations are already integrated within the CBM-CFS3 modelling (below).

In Equation 12 (which is input into Equations 11a and 11b), the annual increase in LDW biomass ($LDW_{BSL,IN,i,t}$) accounts for the annual loss of live tree biomass due to natural mortality, commercial felling, and from incidental sources ($LBL_{BSL,NATURAL,i,t}$, $LBL_{BSL,FELLINGS,i,t}$, and $LBL_{BSL,OTHER,i,t}$, respectively) and applies annual proportions of live aboveground tree biomass subject to blowdown, aboveground tree biomass comprised of branches > 5 cm diameter, and the log bole biomass left on site after assessing and/or merchandizing the log bole for quality ($f_{BSL,BLOWDOWN,i,t}$, $f_{BSL,BRANCH,i,t}$, and $f_{BSL,BUCKINGLOSS,i,t}$, respectively), and accounts for increases from the total mass of the snag pool ($SNAG_{BSL,i,t}$) with application of an annual proportion of snag biomass that falls over and thus is transferred to the LDW pool ($f_{BSL,SNAGFALLDOWN,i,t}$). Belowground biomass is excluded from this by utilizing the root:shoot ratio (Ri). This equation is unnecessary as the amount of increase to the lying dead wood pool (or select Aboveground DOM pools) is already accounted for in CBM-CFS3 with integrated parameters for carbon transfers from natural, felling, and infrastructure sources that are region- (in the case of natural) and management-specific (in the case of roads and infrastructure).

The annual loss in LDW biomass through decay ($LDW_{BSL,OUT,i,t}$) is defined by Equation 13 (which is input into Equations 11a and 11b) as the annual proportional loss of lying dead biomass due to decay ($f_{BSL,lwDECAY,i,t}$) applied to the total mass of lying dead wood accumulated

(LDWBSL,i,t). This equation is unnecessary because the loss of lying dead biomass due to decay is integrated into CBM-CFS3 with region-specific decay (or turnover rates), and the total mass of lying dead wood (or select Aboveground DOM pools) of each stand is already calculated in tons of carbon each year by the model.

Change in Snag Carbon Stock

The change in snag carbon stock (ΔCBSL,SNAG,t) is defined by Equations 14a and 14b, which applies the carbon fraction (CF) to the annual gain in snag biomass (SNAGBSL,IN,i,t) and the annual loss in snag biomass through decay, or falldown (i.e, transfer to the LDW pool) (SNAGBSL,OUT,i,t) to the total mass of snags accumulated (SNAGBSL,i,t). However, the function of these equations are already integrated within the CBM-CFS3 modelling (below).

In Equation 15 (which is input into Equations 14a and 14b, the annual gain in snag biomass (SNAGBSL,IN,i,t) is calculated by applying the proportion of live tree aboveground biomass that dies but remains as standing dead organic matter (i.e., snags) (1-fBSL,BLOWDOWN,i,t) to the annual loss of live tree biomass due to natural mortality (LBLBSL,NATURAL,i,t), and belowground biomass is excluded using the root:shoot ratio (Ri). This equation is unnecessary as the amount of increase to the snags pool (or Softwood/Hardwood Stem/Branch Snag pools) is already accounted for in CBM-CFS3 with integrated parameters for carbon transfers from natural causes that are region-specific.

The annual loss in snag biomass through decay, or falldown (i.e, transfer to the LDW pool) (SNAGBSL,OUT,i,t) is defined by Equation 16 (which is input into Equations 14a and 14b) as the annual proportional loss of snag biomass due to decay (fBSL,SWDECAY,i,t) and the annual proportion of snag biomass that falls over and thus is transferred to the LDW pool (fBSL,SNAGFALLDOWN,i,t) applied to the total mass of snags accumulated (SNAGBSL,i,t). This equation is unnecessary because the annual loss in snag biomass through decay, or falldown is integrated into CBM-CFS3 with region-specific decay and transfer rates, and the total mass of snags accumulated (or Softwood/Hardwood Stem/Branch Snag pools) of each stand is already calculated in tons of carbon each year by the model.

Annual Change in DOM Derived from Dead Belowground Biomass

The annual change in DOM derived from dead belowground biomass (ΔCBSL,DBG,t) is defined by Equations 17a and 17b, which applies the carbon fraction (CF) to the annual gain in dead belowground biomass (DBGBSL,IN,i,t) and the annual loss in dead belowground biomass through decay (DBGBSL,OUT,i,t) to the total quantity of dead belowground biomass accumulated (DBGBSL,i,t). However, the function of these equations are already integrated within the CBM-CFS3 modelling (below).

In Equation 17c (which is input into Equations 17a and 17b), the annual gain in dead belowground biomass (DBGBSL,IN,i,t) is calculated by applying annual proportion of biomass that dies from natural mortality, biomass removed by harvesting, and additional biomass removed for road and landing construction (fBSL,NATURAL,i,t, fBSL,HARVEST,i,t, and fBSL,DAMAGE,i,t, respectively) to the belowground portion of average live tree biomass (LBBSL,i,t) using the root:shoot: ratio (Ri) for the area (ha) of forest land (ABSL,i). This equation is unnecessary as the amount of increase to the dead belowground biomass pool (or select Belowground DOM pools) is already accounted for in CBM-CFS3 with integrated parameters for carbon transfers from natural, harvesting, and infrastructure sources that are region- (in the case of natural) and management-specific (in the case of harvesting and infrastructure).

The annual loss in dead belowground biomass through decay (DBGBSL,OUT,i,t) is defined by Equation 17d (which is input into Equation 17a and 17b) as the annual proportional loss of dead belowground biomass due to decay (fBSL,dgbDECAY,i,t) applied to the total quantity of dead belowground biomass accumulated (DBGBSL,i,t). This equation is unnecessary because the loss in dead belowground biomass through decay is integrated into CBM-CFS3 with region-specific decay (or turnover rates), and the total quantity of dead belowground biomass accumulated (or select Belowground DOM pools) of each stand is already calculated in tons of carbon each year by the model.

In summary, Equation 10 was used to calculate the annual change in carbon stocks in DOM (made up of the change in lying dead wood (LDW), snag, and dead belowground biomass carbon stocks). However, Equations 11-17 are unnecessary as the function of these equations are integrated within CBM-CFS3.

Harvested Wood Products

The annual change emissions associated with the production of harvested wood products (HWP) (ΔCBSL,HWP,t) is calculated using Equation 18 by accounting for the annual change in harvested carbon that remains in storage after conversion to wood products (ΔCBSL,STORHWP,t). Note that this project does not account for the annual change in fossil fuel emissions from harvesting (logging and log transport) and processing of the various wood products (ΔCBSL,EMITFOSSIL,t is N/A).

Carbon Storage in Harvested Wood Products

The annual change in harvested carbon that remains in storage after conversion to wood products (ΔCBSL,STORHWP,t) is calculated using Equation 19 by calculating the carbon storage in harvested wood products at time 2 and time 1 divided by the number of years between monitoring time 1 and 2 (T). To calculate the carbon storage in harvested wood products, the carbon contained in timber harvested must first be calculated (see Equation 20 below).

Equation 20 defines the carbon contained in timber harvested (CBSL,TIMBER,h) by applying the proportion of live tree biomass remaining after netting out branch biomass (1-fBSL,BRANCH,i,t) and the proportion of the log bole remaining after in-woods log processing/bucking for quality, length, etc. (1-fBSL,BUCKINGLOSS,i,t) to the annual loss of live tree biomass due to commercial felling (LBLBSL,FELLINGS,i,t) and the annual loss of live tree biomass from incidental sources (LBLBSL,OTHER,i,t), excluding the belowground biomass portion using the root:shoot ratio (Ri). However, this equation is unnecessary because CBM-CFS3 provides the total harvest carbon pool, which is the transfer of carbon from the ecosystem pools to the forest product sector, using management-specific parameters for harvesting and infrastructure disturbances, and includes the carbon harvested from snags (if appropriate). Therefore, the carbon contained in timber harvested (CBSL,TIMBER,h) is provided by CBM-CFS3. Using this, the carbon contained in harvested timber after milling for each product type, k can be calculated (see Equation 21 below).

The carbon contained in harvested timber after milling for each product type (CBSL,MILL,h,k) is calculated using Equation 21 by applying the fraction of growing stock volume removed as roundwood for product type k (fRND,k), and the ratio of industrial roundwood to growing stock volume removed as roundwood for product type k (rRND,k) to the carbon contained in timber harvested for product type k (CBSL,TIMBER,h,k). Along with this, the short-, long-, and medium-lived fractions must be calculated for each product type (see Equations 22a, 22b, and 22c below)

Equation 22a is used to calculate the short-lived fraction (PBSL,SLF,k) as harvested wood products and wood waste that will decay within 3 years (1-P3-year). Equation 22b is used to calculate the long- lived fraction (PBSL,LLF,k) as harvested wood products and wood waste that may be considered permanent (stored for 100 years or more) (P100-year). Equation 22c is used to calculate the medium-lived fraction (PBSL,MLF,k) as harvested wood products and wood waste that will be retired between 3 and 100 years from the date of harvest (P3-year - P100-year). Each category of wood products (k) stores carbon according to the following rules:

i. Short-lived wood products – immediate emission of all carbon upon harvest

ii. Medium-lived wood products – no emission of carbon upon harvest, but carbon stored will decrease by 1/20th for the next 20 years after harvest, such that after 20 years the term becomes zero

iii. Long-lived wood products – no loss of carbon.

Finally, Equation 23 is used to calculate the carbon stored in harvested wood products in each year summed for all product types (k) and then over all harvest periods (h) (CBSL,STORHWP,t) by applying the medium-lived fraction with a 20-year linear decay rate (PBSL,MLF,k), and the long-lived fraction with no loss of carbon (PBSL,LLF,k), to the carbon contained in harvested timber after milling in each period (h), for each product type (k) (CBSL,MILL,h,k).

Fossil Fuel Emissions Associated with Logging, Transport, and Manufacture

The annual change in fossil fuel emissions from harvesting and processing of the various wood products is not accounted in this project. Therefore, Equations 24, 25, 26, and 27 are not applicable.

4.2 Project Emissions

Net project emissions were calculated by repeating the procedures in the baseline emissions calculations in Section 4.1 above.

The project scenario involves a reduction in annual harvest of 80% across the property, compared to the baseline scenario. Strategic harvesting will continue at 20% of the annual baseline harvest volume – **** m^3 – for the purposes of forest health maintenance. This project allowable annual cut will operate in 5-year cycles; within which under- and over-cuts are allowable, as long as the total 5-year allowable cut is not exceeded within that period.

Project Scenario Area Stratification

The same inventory data and stratification methods were used for the project scenario as the baseline scenario as described in Section 4.1 above.

Determining Actual Onsite Carbon Stocks

Actual carbon stocks are calculated prior to each verification (at a maximum interval of 5 year) by updating the project's forest carbon inventory from monitoring data.

In accordance with the methodology, this is done by:

1. Incorporating any new forest inventory data (including data from new or re-measured sampling plots and other monitored data, as outlined in Section 9.2 and 9.3 of VM0012) obtained during the previous year into the inventory estimate.
2. Updating the forest inventory for spatial monitoring results, including annual project activities and/or disturbances that have occurred during the monitoring period.
3. Using the selected model(s) to project prior-year data from the forest inventory to the current reporting year (as described in Section 8.2.5 of VM0012).
4. Comparing estimates of live biomass and dead organic matter in polygons and calculated from monitoring activities (Section 9.2 and 9.3 of VM0012) against current-year modelled values in the project scenario (see Section 8.2.4 of VM0012).
5. Making calibration adjustments to models and/or parameters such that the fit between the equivalent modelled and measured variables meets targets (as per Section 8.2.4 of VM0012).
6. If any changes are made to the model assumptions or parameters used in Section 8.2, the calculation of baseline emissions (from the current date forward) must be redone using the updated model(s) and parameter sets.
7. Calculate the error terms for use in determining the uncertainty factor (Section 8.5.3 of VM0012).

Ex-Post Calculations of Carbon Stocks

Equations 28a, 28b, 28c, 28d, and 28e were used to calculate the actual carbon stocks.

Updating the Modelled Project Carbon Balance

The precision of the modelled carbon stocks will be evaluated for each polygon using the method described in Section 8.5.3 (Equations 60a and 60b) of VM0012. In accordance with the

methodology, if changes in model assumptions or parameters are made, the baseline scenario (from the next year forward) must be recalculated using the revised model.

Calculating the Project Carbon Balance

The total annual carbon balance for the project scenario is calculated using Equation 29, which is equal to the annual change in carbon stocks in all pools in the project across the project activity area ($\Delta C_{PRJ,P,t}$).

The annual change in carbon stocks in all pools in the project across the project activity area ($\Delta C_{PRJ,P,t}$) is calculated using Equation 30 by summation of the annual change in carbon stocks in living tree biomass (above- and belowground), in dead organic matter, and associated with harvested wood products ($\Delta C_{PRJ,LB,t}$, $\Delta C_{PRJ,DOM,t}$, and $\Delta C_{PRJ,HWP,t}$, respectively).

Equation 32 defines the annual change in carbon stocks in living tree biomass (above- and belowground) ($\Delta C_{PRJ,LB,t}$) as the annual increase in tree carbon stock from growth ($\Delta C_{PRJ,G,t}$) and the annual decrease in tree carbon stock from a reduction in live biomass ($\Delta C_{PRJ,L,t}$). However, this equation is not applicable because the outputs of the CBM-CFS3 model for carbon stocks in living tree biomass (above- and belowground) already accounts for live biomass gain and loss (see Live Biomass Gain and Live Biomass Loss sections below).

Live Biomass Gain

Calculation of live biomass gain ($\Delta C_{PRJ,G,t}$) in Equations 32, 33a, and 33b are not necessary because the function of these equations are integrated within CBM-CFS3. See Section 4.2 for details.

Live Biomass Loss

Calculation of live biomass loss ($\Delta C_{PRJ,L,t}$) in Equations 34, 35, 36, and 37 are not necessary because the function of these equations are integrated within CBM-CFS3. See Section 4.2 for details.

Dead Organic Matter Dynamics

The annual change in carbon stocks in DOM (ΔCPRJ,DOM,t) is calculated by Equation 38 as the summation of change in lying dead wood (LDW), snag, and dead belowground biomass carbon stocks (ΔCPRJ,LDW,t, ΔCPRJ,SNAG,t, and ΔCPRJ,DBG,t, respectively).

However, the change in lying dead wood (LDW) carbon stocks (ΔCPRJ,LDW,t), change in snag carbon stock (ΔCPRJ,SNAG,t) and the change in belowground carbon stock (ΔCPRJ,BDG,t), are all accounted for within CBM-CFS3 in tons of carbon for each year.

Therefore, Equations 39a, 39b, 40, 41, 42a, 42b, 43, 44, 45a, 45b, 45c, and 45d are unnecessary because the function of these equations are integrated within CBM-CFS3. See Section 4.2 for details.

Harvested Wood Products

The annual change emissions associated with the production of harvested wood products (HWP) (ΔCPRJ,HWP,t) is calculated using Equation 46 by accounting for the annual change in harvested carbon that remains in storage after conversion to wood products (ΔCPRJ,STORHWP,t). Note that this project does not account for the annual change in fossil fuel emissions from harvesting (logging and log transport) and processing of the various wood products (ΔCPRJ,EMITFOSSIL,t is N/A).

Carbon Storage Harvested Wood Products

The calculation of carbon storage in harvested wood products for the project emissions applied the same process from the baseline emissions (see Section 4.2).

Equation 47 is used to calculate annual change in harvested carbon that remains in storage after conversion to wood products (ΔCPRJ,STORHWP,t)

Equation 48 is unnecessary because the carbon contained in timber harvested (CPRJ,TIMBER,h) is provided by CBM-CFS3.

Equation 49 is used to calculate the carbon contained in harvested timber after milling in each period (h), for each product type (k) (CPRJ,MILL,h,k).

Equation 50a, 50b, and 50c, are used to calculate the short-lived fraction (PPRJ,SLF,k), long-lived faction (PPRJ,LLF,k), and medium-lived fraction (PPRJ,MLF,k), respectively.

Finally, Equation 51 is used to calculate carbon stored in harvested wood products summed for all product types k and then over all harvest periods h (CPRJ,STORHWP,t).

Fossil Fuel Emissions Associated with Logging, Transport, and Manufacture

The annual change in fossil fuel emissions from harvesting and processing of the various wood products is not accounted in this project. Therefore, Equations 52, 53, 54, and 55 are not applicable.

4.3 Leakage

Activity Shifting Leakage

The project proponent owns multiple properties within Canada and will annually provide validators and/or verifiers the locations and descriptions of all forestland properties.

In accordance with the methodology, the project proponent will demonstrate annually that there is no activity shifting leakage to other properties operated by the project proponent as a result of the project activity (i.e., harvest rates have not been increased). Demonstration of this will include:

1. Historical records showing trends in harvest volumes paired with records from the project time period showing no deviation from historical trends, or
2. Forest management plans prepared ≥ 24 months prior to the start of the project showing harvest plans on all owned/managed lands paired with records from the project time period showing no deviation from management plans; and/or
3. Other evidence and justification to demonstrate activity shifting related to the project is not occurring

Market Leakage

This project will use the default VCS market leakage method in VM0012. The VCS leakage discount method (see table below) is based on the comparison of the ratio of merchantable biomass to total tree biomass (aboveground + belowground) in the project area to the same ratio in a likely leakage area. For this project the likely leakage area is technically defined as the regional Algoma Crown forest area. Rather than account for market leakage at the country scale,

this project has opted to use a regional scale (i.e. provincial scale) as log markets in Canada are highly regional and there are laws that prohibit transport and sale of logs across provincial boundaries. Domestic market leakage in Canada is a regional/provincial phenomenon, not a national phenomenon, for the following demonstrable reason:

1. Log markets are regulated provincially, and inter-provincial log transport and sales are generally prohibited by law under the Constitution Act, Section 121.

Biomass ratios for the VCS market leakage factors were calculated using data collected from the project area and regional data from the Algoma Forest Management Plan (Appendix) This Algoma crown forest is directly adjacent to the project area and represents a very large timber supply area that has similar tree species, ecosystems, log markets and manufacturing facilities that are relevant to project market leakage risks.

Market Leakage Total Biomass Calculation:

eFRI will inform calculations of project area total biomass and merchantable biomass.

The leakage area merch/total ratio of XXXX is higher than the Project merch/total ratio of XXX for the initial validation and so the VCS Leakage Discount Factor of 20% applies. As per VCS methodology convention “higher” is defined as greater than 15%.

Table 9.

Project Action	Leakage Risk	Leakage Discount Factor
IFM activity with no effect or minimal effect on total timber harvest volumes (e.g., RIL with less than 25% reduction)	None	0%
IFM activity that leads to a shift in harvests across time periods but minimal change in total timber harvest over time (e.g., ERA with rotation extension of 5-10 years)	Low	10%
IFM activity that substantially reduces harvest levels permanently (e.g., RIL activity that reduces timber harvest across the project area, or project that halts logging by at least 25%)	Moderate to High	Conditional upon where timber harvest is likely to be shifted, as follows: • Where the ratio of merchantable biomass to total biomass is higher within the area to which harvesting is displaced compared to the project area, 20% • Where the ratio of merchantable biomass to total biomass is similar within the area to which harvesting is displaced compared to the project area, 40% • Where the ratio of merchantable biomass to total biomass is lower within the area to which harvesting is displaced compared to the project area, 70%

The outcome of the VCS Leakage Discount Factor determination (above) is used in Equation 56a for the value of the market leakage factor (MLF_y), which is used in the following Equation 56b to calculate the project market leakage (LE_y).

4.4 Net GHG Emission Reductions and Removals

Summary of Gross Emissions Reductions and/or Removals

The gross carbon emissions reductions ($ER_{y,GROSS}$) is calculated using Equation 57. This is calculated annually as the difference between the baseline and project scenario net emission reductions/emissions. See

Table *10* below.

Summary or Net Emissions Reductions and/or Removals

The annual net carbon emissions reductions (ER_y) is calculated using Equation 58. This is calculated annually as the gross carbon emissions reductions minus the project market leakage. See

Table *10* below.

Calculation of Voluntary Credit Units (VCUs)

The number of VCU's the project will have available for issuance and sale (VCU_y) is calculated in Equation 59. This is calculated by applying the uncertainty factor ($ER_{y,ERR}$, see below) to the net GHG emissions reductions and/or removals and then minus the estimated VCU-equivalent tCO_2e issued to the VCS Buffer Pool (BR_y). See

Table *10* below. In accordance with the methodology, BR_y is calculated by multiplying the most current verified permanence risk Buffer Withholding Percentage for the project by the change in carbon stocks (difference between baseline and project scenario) for the project area as per the latest approved VCS AFOLU Requirements (Voluntary Carbon Standard, 2008a).

The calculated risk score, based on the AFOLU Non-Permanence Risk Tool[9], is 3, which is below the minimal allowable score of 10. As such, the minimum score of 10 is applied, translated to 10%. The buffer allocation is therefore calculated as **** tCO_2e.

Table 10. Estimated emission or removals

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
1	4,153,491	4,215,490	(51,436)	222,789
2	4,145,841	4,274,122	(54,141)	234,505
3	4,131,842	4,329,917	(56,357)	244,105
4	4,134,717	4,403,978	(57,237)	247,915
5	4,131,945	4,473,733	(58,083)	251,581
6	4,127,743	4,543,348	(58,898)	255,110
7	4,122,376	4,613,043	(59,683)	258,513
8	4,114,066	4,677,178	(58,031)	251,357
9	4,100,931	4,737,094	(58,414)	253,017
10	4,086,195	4,795,975	(58,771)	254,560
11	4,071,596	4,855,532	(59,112)	256,036
12	4,058,057	4,914,361	(57,983)	251,148
13	4,043,976	4,972,890	(58,135)	251,808
14	4,021,535	5,020,396	(56,454)	244,524
15	3,979,548	5,048,224	(56,371)	244,165

[9] https://verra.org/wp-content/uploads/2019/09/AFOLU_Non-Permanence_Risk-Tool_v4.0.pdf

16	3,936,751	5,075,242	(56,371)	244,167
17	3,887,813	5,101,978	(60,070)	260,185
18	3,837,450	5,128,376	(60,757)	263,161
19	3,789,821	5,165,153	(65,583)	284,067
20	3,738,928	5,199,291	(65,978)	285,777
21	3,686,975	5,233,391	(66,624)	288,572
22	3,633,870	5,267,314	(67,239)	291,240
23	3,579,848	5,301,253	(67,827)	293,787
24	3,521,126	5,325,201	(64,487)	279,321
25	3,459,354	5,345,975	(64,410)	278,982
26	3,396,673	5,366,414	(64,772)	280,551
27	3,332,967	5,386,380	(65,119)	282,058
28	3,268,513	5,406,126	(65,454)	283,505
29	3,205,835	5,432,201	(68,328)	295,954
30	3,140,578	5,454,934	(67,847)	293,870
31	3,075,098	5,477,996	(68,194)	295,376
32	3,009,179	5,501,148	(68,529)	296,825
33	2,942,258	5,523,809	(68,852)	298,224
34	2,872,945	5,542,134	(67,623)	292,904
35	2,800,032	5,545,543	(60,479)	261,961
36	2,726,709	5,548,412	(60,398)	261,605
37	2,653,402	5,551,167	(60,315)	261,246
38	2,580,186	5,553,881	(60,232)	260,888

39	2,506,956	5,556,453	(60,151)	260,535
40	2,437,503	5,558,601	(57,499)	249,051
Total	142,444,629	204,423,659	(2,462,244)	10,664,945

Uncertainty Factor Calculation

An uncertainty factor is applied by employing an over-riding project confidence deduction as a proxy for collective project uncertainty by assessing statistical uncertainty in the forest carbon inventory and associated modelling in accordance with the methodology requirements. The steps are summarized below:

1. The average percent model error (E_M) for the project based on the average area-weighted difference between measured values in monitored plot observations and model-predicted values is calculated using Equations 60a and 60b.
2. Then, the inventory error (E_I) at a 90% confidence interval expressed as a percentage of the mean area-weighted inventory estimate from the measured plots is calculated using Equations 60c, 60d, and 60e.
3. Finally, the total error for the project (E_P) is calculated by adding the model and inventory error terms, as calculated above in Steps 1 and 2 using Equation 60f.
4. The result of Step 3 (above) is compared against Table 6 (of the methodology) to determine the uncertainty factor, where:
    a. If Estimated Project Error, (E_P; %) is between 0 and 10%, then the Uncertainty Factor ($ER_{y,ERR}$) is equal to 1.5%.
    b. If Estimated Project Error, E_P (%) is greater than 10%, then the Uncertainty Factor ($ER_{y,ERR}$) is equal to 1.5% + E_P – 10%.
5. *eFRI derived calculations will inform Uncertainty determination.*

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	$A_{BSL,i}$
Data unit	Ha
Description	Area of baseline polygon, i
Used in	Various equations from Equation #4-17.
Source of data	Land title records and geospatial files.
Value applied	###
Justification	Area of the property according to land title records and geospatial files.
Measurement procedures	n/a
Comments	

Data / Parameter	$\Delta C_{,t}$
Data unit	tC/yr
Description	The annual carbon balance in the baseline or project scenario for year, t
Used in	Equation 57, labeled by baseline (BSL) and project (PRJ).
Source of data	Calculated in equation 1 (Section 8.1); equation 29 (Section 8.2). Labeled with subscript BSL and PRJ, respectively.
Value applied	See Table/Annex/Worksheet ###.
Justification	$\Delta C_{BSL,t}$ is calculated in Equation 1 $\Delta C_{PRJ,t}$ is calculated in Equation 29
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$\Delta C_{P,t}$
Data unit	tC/yr
Description	The annual change in carbon stocks in all pools in the baseline or project scenario across the project activity area for year, t
Used in	Calculation of $\Delta C,t$
Source of data	Calculated in equation 2 (Section 8.1); equation 30 (Section 8.2)
Value applied	See Table/Annex/Worksheet ###.
Justification	$\Delta C_{BSL,P,,t}$ is calculated in Equation 2 $\Delta C_{PRJ,P,t}$ is calculated in Equation 30
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$\Delta C_{LB,t}$
Data unit	tC/yr
Description	The annual change in carbon stocks in living tree biomass (above- and belowground) for year, t
Used in	Calculation of $\Delta C_{P,t}$
Source of data	Calculated in equation 3 (Section 8.1); equation 31 (Section 8.2)
Value applied	See Table/Annex/Worksheet ###.
Justification	$\Delta C_{BSL,LB,t}$ is a modelled output of CBM-CFS3 $\Delta C_{PRJ,LB,t}$ is a modelled output of CBM-CFS3
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$\Delta C_{DOM,t}$
Data unit	tC/yr
Description	The annual change in carbon stocks in dead organic matter for year, t
Used in	Calculation of $\Delta C_{P,t}$
Source of data	Calculated in equation 10 (Section 8.1); equation 38 (Section 8.2)
Value applied	See Table/Annex/Worksheet ###.
Justification	$\Delta C_{BSL,DOM,t}$ is calculated in Equation 10 $\Delta C_{PRJ,DOM,t}$ is calculated in Equation 38
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$\Delta C_{HWP,t}$
Data unit	tC/yr
Description	The annual change in carbon stocks in harvested wood products for year, t
Used in	Calculation of $\Delta C_{P,t}$
Source of data	Calculated in equation 18 (Section 8.1); equation 46 (Section 8.2)
Value applied	See Table/Annex/Worksheet ###.
Justification	$\Delta C_{BSL,HWP,t}$ is calculated in Equation 18 $\Delta C_{PRJ,HWP,t}$ is calculated in Equation 46
Measurement procedures	n/a

Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$\Delta C_{G,t}$
Data unit	tC/yr
Description	The annual change in carbon stocks due to live biomass gain for year, t
Used in	Calculation of $\Delta C_{LB,t}$
Source of data	Calculated in equation 4 (Section 8.1); equation 32 (Section 8.2)
Value applied	n/a
Justification	Value modelled within CBM-CFS3
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$\Delta C_{L,t}$
Data unit	tC/yr
Description	The annual change in carbon stocks due to live biomass loss for year, t
Used in	Calculation of $\Delta C_{LB,t}$
Source of data	Calculated in equation 6 (Section 8.1); equation 34 (Section 8.2)
Value applied	n/a
Justification	Value modelled within CBM-CFS3
Measurement procedures	n/a

Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$\Delta C_{LDW,t}$
Data unit	tC/yr
Description	The annual change in lying dead wood carbon stocks for year, t
Used in	Calculation of $\Delta C_{DOM,t}$
Source of data	Calculated in equations 11a, 12, 13 (Section 8.1); equations 39a, 40, 41 (Section 8.2)
Value applied	See Table/Annex/Worksheet ###.
Justification	$\Delta C_{BSL,LDW,t}$ is a modelled output of CBM-CFS3 $\Delta C_{PRJ,LDW,t}$ is a modelled output of CBM-CFS3
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$\Delta C_{SNAG,t}$
Data unit	tC/yr
Description	The annual change in standing dead wood carbon stocks for year, t
Used in	Calculation of $\Delta C_{DOM,t}$
Source of data	Calculated in equations 14a, 15, 16 (Section 8.1); equations 42a, 43, 44 (Section 8.2)
Value applied	See Table/Annex/Worksheet ###.
Justification	$\Delta C_{BSL,SNAG,t}$ is a modelled output of CBM-CFS3 $\Delta C_{PRJ,SNAG,t}$ is a modelled output of CBM-CFS3

Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$\Delta C_{DBG,t}$
Data unit	tC/yr
Description	The annual change in dead belowground carbon stocks for year, t
Used in	Calculation of $\Delta C_{DOM,t}$
Source of data	Calculated in equations 17a, 17c, 17d (Section 8.1); equations 45a, 45c, 45d (Section 8.2)
Value applied	See Table/Annex/Worksheet ###.
Justification	$\Delta C_{BSL,DBG,t}$ is a modelled output of CBM-CFS3 $\Delta C_{PRJ,DBG,t}$ is a modelled output of CBM-CFS3
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	CF
Data unit	tC/tdm
Description	Carbon fraction of dry matter
Source of data	IPCC default value = 0.5, if more relevant values are not available
Value applied	0.5
Justification	IPCC default value used.
Measurement procedures	n/a

Comments	

Data / Parameter	R_i
Data unit	unitless
Description	Root:shoot ratio in polygon, i
Source of data	If project-specific values have not been measured, use Cairns 1997.
Value applied	n/a
Justification	Value is contained within CBM-CFS3
Measurement procedures	n/a
Comments	Root allocation can be vary by site productivity; relatively more biomass may be allocated to roots in poor than richer soils

Data / Parameter	BEF
Data unit	unitless
Description	Biomass expansion factors for conversion of productivity metrics to biomass
Source of data	The source of data must be chosen with priority from higher to lower preference as follows: (a) Existing local and forest type-specific; (b) National and forest type-specific or eco-region-specific (e.g. from national GHG inventory); (c) Forest type-specific or eco-region-specific from neighboring countries with similar conditions. Sometimes (c) might be preferable to (b); (d) Globally forest type or eco-region-specific (e.g. IPCC literature: Table 3A.1.10 of GPG-LULUCF)
Value applied	n/a
Justification	Value is contained within CBM-CFS3
Measurement procedures	n/a

Comments	BEFs are age dependent, and use of average data may result in significant errors for both young and old stands – as BEFs are usually large for young stands and quite small for old stands.

Data / Parameter	$f_{BRANCH,i,t}$
Data unit	unitless
Description	The annual proportion of aboveground tree biomass comprised of branches > 5 cm diameter in polygon, i
Source of data	The source of data must be chosen with priority from higher to lower preference as follows: (a) Research publications relevant to the project area; (b) National and species-specific or group of species-specific (e.g. from National GHG inventory); (c) Species-specific or group of species-specific from neighboring countries with similar conditions. Sometimes (b) may be preferable to (a); (d) Globally species-specific or group of species-specific (e.g. IPCC GPGLULUCF).
Value applied	n/a
Justification	Value is contained within CBM-CFS3
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, same value

Data / Parameter	$f_{BUCKINGLOSS,i,t}$
Data unit	unitless
Description	Annual proportion of the log bole biomass left on site after assessing and/or merchandizing the log bole for quality, in polygon, i
Source of data	Preferably, data for this variable must be based on regional and local comparative studies and experiential information derived from the local forest industry. Otherwise, an average default

	value of 21% can be used, based on US national summary statistics (Smith, Miles, Vissage, & Pugh, 2004).
Value applied	n/a
Justification	Value is contained within CBM-CFS3
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$P_{3\text{-year}}$ and $P_{100\text{-year}}$
Data unit	unitless
Description	The proportion of total carbon stored in wood products after 3 years (P3-year); and the proportion of harvested wood stored for 100 years (P100-year), for product type, k
Source of data	Calculated for the baseline and project case
Value applied	$P_{3\text{-year}} = 0.468$ $P_{100\text{-year}} = 0.073$
Justification	Values from Smith et al. (2006), weighted to account for the 5 year average harvest volumes by product in Ontario.
Measurement procedures	n/a
Comments	

Data / Parameter	$P_{BSL,SLF}$, $P_{BSL,MLF}$, $P_{BSL,LLF}$
Data unit	unitless
Description	The short-lived fraction (PSLF), medium-lived fraction (PMLF), and long-lived fraction (PLLF), respectively, for product type, k
Source of data	Calculated as per equations 22a-c (baseline) and equations 50ac (project)

Value applied	$P_{BSL,SLF}$ = 0.532 $P_{BSL,MLF}$ = 0.395 $P_{BSL,LLF}$ = 0.073
Justification	Calculated as per equations 22a-c (baseline)
Measurement procedures	n/a
Comments	

Data / Parameter	$f_{TRANSPORTk}$
Data unit	(unitless; 0 < fBSL,TRANSPORTk < 1).
Description	The fraction of raw material transported by transportation type, k.
Source of data	Estimated based on Heath et al. 2006 Supplementary
Value applied	n/a
Justification	Fossil fuel emissions excluded from this project
Measurement procedures	n/a
Comments	Variables used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$C_{HARVEST}$
Data unit	t C emitted/t C raw material
Description	The carbon emission intensity factor associated with harvesting
Source of data	See Table 4 (of VM0012 methodology)
Value applied	n/a
Justification	Fossil fuel emissions excluded from this project
Measurement procedures	n/a

Comments	

Data / Parameter	$C_{MANUFACTURE_k}$
Data unit	t C emitted/t C raw material
Description	The carbon emission intensity factor associated with manufacture of product, k
Source of data	See Table 4 (of VM0012 methodology)
Value applied	n/a
Justification	Fossil fuel emissions excluded from this project
Measurement procedures	n/a
Comments	

Data / Parameter	$C_{TRANSPORT_k}$
Data unit	t C emitted/t C raw material ● km
Description	The carbon emission intensity factor associated with the transport of raw material by transportation type of product, k
Source of data	See Table 4 (of VM0012 methodology)
Value applied	n/a
Justification	Fossil fuel emissions excluded from this project
Measurement procedures	n/a
Comments	

Data / Parameter	$d_{TRANSPORT_k}$
Data unit	km

Description	The distance transported by transportation type, k.
Source of data	Estimated based on Heath et al. 2006 Supplementary
Value applied	n/a
Justification	Fossil fuel emissions excluded from this project
Measurement procedures	n/a
Comments	

Data / Parameter	$C_{EMITTRANSPORT,t}$
Data unit	tC/yr
Description	The annual fossil fuel emissions associated with the transport of raw material
Source of data	Heath et al. 2006 Supplementary
Value applied	n/a
Justification	Fossil fuel emissions excluded from this project
Measurement procedures	n/a
Comments	Variables used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$G_{AG,i,t}$
Data unit	tdm/ha/yr
Description	Annual increment rate in aboveground biomass (tdm/ha/yr), in polygon, i,
Source of data	Modeled (See Section 8.1 & Section 8.2)
Value applied	n/a
Justification	Value modelled within CBM-CFS3

Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$G_{BG,i,t}$
Data unit	tdm/ha/yr
Description	Annual increment rate in belowground biomass (tdm/ha/yr), in polygon, i,
Source of data	Calculated from G_{AG} and R_i
Value applied	n/a
Justification	Value modelled within CBM-CFS3
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$LBL_{NATURAL,i,t}$
Data unit	tdm/yr
Description	Annual loss of live tree biomass due to natural mortality in polygon, i; tdm/yr
Source of data	Modeled (See Section 8.1 & Section 8.2)
Value applied	n/a
Justification	Value modelled within CBM-CFS3
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$LBL_{FELLINGS,i,t}$
Data unit	tdm/yr
Description	Annual loss of live tree biomass due to commercial felling in polygon, i; tdm/yr
Source of data	Modeled (See Section 8.1 & Section 8.2)
Value applied	n/a
Justification	Value modelled within CBM-CFS3
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$LBL_{OTHER,i,t}$
Data unit	tdm/yr
Description	Annual loss of live tree biomass from incidental sources in polygon, i; tdm/yr
Source of data	Modeled (See Section 8.1 & Section 8.2)
Value applied	n/a
Justification	Value modelled within CBM-CFS3
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$LB_{i,t}$
Data unit	tdm/yr
Description	Average live tree biomass in polygon, i, for year, t

Source of data	Calculated from $G_{i,t}$
Value applied	n/a
Justification	Value modelled within CBM-CFS3
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$f_{BSL,NATURAL,i,t}$
Data unit	unitless; $0 < f_{NATURAL,i,t} < 1$
Used in	Equation 7, Section 8
Description	The annual proportion of biomass that dies from natural mortality in forest type analysis unit or polygon, i, year, t.
Source of data	Literature reports, and/or inventory data.
Value applied	n/a
Justification	Value is contained within CBM-CFS3
Measurement procedures	n/a
Comments	

Data / Parameter	$f_{BSL,HARVEST,i,t}$
Data unit	unitless; $0 < f_{BSL,HARVEST,i,t} < 1$
Used in	Equation 8, Section 8.1
Description	The proportion of biomass removed by harvesting from polygon, i, in year, t.
Source of data	Literature reports, and/or inventory data.
Value applied	n/a

Justification	Value is contained within CBM-CFS3
Measurement procedures	n/a
Comments	

Data / Parameter	$f_{BSL,DAMAGE,i,t}$
Data unit	unitless; $0 < f_{BSL,DAMAGE,i,t} < 1$
Used in	Equation 9, Section 8
Description	The proportion of additional biomass removed for road and landing construction in polygon, i, year, t
Source of data	Literature reports, and/or inventory data.
Value applied	n/a
Justification	Value is contained within CBM-CFS3
Measurement procedures	n/a
Comments	

Data / Parameter	$f_{BSL,BLOWDOWN,i,t}$
Data unit	unitless; $0 < f_{BSL,BLOWDOWN,i,t} < 1$
Used in	Equation 12, Section 8.1
Description	The annual proportion of live aboveground tree biomass subject to blowdown in polygon, i, year, t.
Source of data	Literature reports, and/or inventory data.
Value applied	n/a
Justification	Value is contained within CBM-CFS3
Measurement procedures	n/a

Comments	

Data / Parameter	$f_{BSL,SNAGFALLDOWN,i,t}$
Data unit	unitless; $0 < f_{BSL,SNAGFALLDOWN,i,t} < 1$
Used in	Equations 12 & 16, Section 8.1
Description	The annual proportion of snag biomass in polygon, i, year, t, that falls over and thus is transferred to the LDW pool.
Source of data	Literature reports, and/or inventory data.
Value applied	n/a
Justification	Value is contained within CBM-CFS3
Measurement procedures	n/a
Comments	

Data / Parameter	$f_{BSL,lwDECAY,i,t}$
Data unit	unitless; $0 < f_{BSL,lwDECAY,i,t} < 1$
Used in	Equation 13, Section 8.1
Description	The annual proportional loss of lying dead biomass due to decay, in polygon i, year, t.
Source of data	Literature reports, and/or inventory data.
Value applied	n/a
Justification	Value is contained within CBM-CFS3
Measurement procedures	n/a
Comments	

Data / Parameter	$f_{BSL,SWDECAY,i,t}$
Data unit	unitless; $0 < f_{BSL,SWDECAY,i,t} < 1$
Used in	Equation 16, Section 8.1
Description	The annual proportional loss of snag biomass due to decay, in polygon, i, year, t.
Source of data	Literature reports, and/or inventory data.
Value applied	n/a
Justification	Value is contained within CBM-CFS3
Measurement procedures	n/a
Comments	

Data / Parameter	$SNAG_{BSL,i,t}$
Data unit	tdm/yr
Description	The total amount of snag mass in polygon i, year, t
Source of data	Calculated in equations 14b, 15,16
Value applied	n/a
Justification	Carbon pool is modelled within CBM-CFS3
Measurement procedures	n/a
Comments	

Data / Parameter	$DBG_{,i,t}$
Data unit	tdm/yr
Description	The total quantity of dead belowground biomass accumulated in polygon i since the project start; t biomass.

Source of data	Calculated in equations 17b, 17c,17d (Section 8.1); Calculated in equations 45b, 45c,45d (Section 8.2)
Value applied	n/a
Justification	Unnecessary as carbon pool is modelled within CBM-CFS3
Measurement procedures	Modeled.
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$\Delta C_{STORHWP1,t}$
Data unit	tC/yr
Used in	The calculation of the annual change in emissions associated with the production of harvested wood products (HWP), $\Delta C_{BSL,HWP,t}$
Description	Annual harvested carbon that remains in permanent storage after conversion to wood products during primary processing
Source of data	Calculated in equation 19 (Section 8.1) and equation 47 (Section 8.2)
Value applied	See Table/Annex/Worksheet ###.
Justification	$\Delta C_{BSL,STORHWP1,t}$ is calculated in Equation 19 $\Delta C_{PRJ,STORHWP1,t}$ is calculated in Equation 47
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$C_{MILL,h,k}$
Data unit	tC

Used in	The calculation of the annual change in the carbon stored in harvested wood products (HWP), $\Delta C_{BSL,HWP,t}$
Description	The carbon contained in harvested timber after milling in period h, for product type k
Source of data	Calculated in equation 21 (Section 8.1) and equation 49 (Section 8.2)
Value applied	See Table/Annex/Worksheet ###.
Justification	$\Delta C_{BSL,MILL,h,k}$ is calculated in Equation 21 $\Delta C_{PRJ,MILL,h,k}$ is calculated in Equation 49
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$C_{TIMBER,h}$
Data unit	tC
Used in	The calculation of the annual change in the carbon stored in harvested wood products (HWP), $\Delta C_{BSL,HWP,t}$
Description	The carbon contained in timber harvested in period h
Source of data	Calculated in equation 20 (Section 8.1) and equation 48 (Section 8.2)
Value applied	See Table/Annex/Worksheet ###.
Justification	$C_{BSL,TIMBER,h}$ is a modelled output of CBM-CFS3 $C_{PRJ,TIMBER,h}$ is a modelled output of CBM-CFS3
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$C_{STORHWP,h,t}$
Data unit	tC
Used in	The calculation of the annual change in the carbon stored in harvested wood products (HWP), $\Delta C_{BSL,HWP,t}$
Description	The carbon stored in harvested wood products in year t summed for all product types k and then over all harvest periods h; t C
Source of data	Calculated in equation 23 (Section 8.1) and equation 51 (Section 8.2)
Value applied	See Table/Annex/Worksheet ###.
Justification	$\Delta C_{BSL,STORHWP,h,t}$ is calculated in Equation 23 $\Delta C_{PRJ,STORHWP,h,t}$ is calculated in Equation 51
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$f_{RND,k}$
Data unit	dimensionless
Used in	The calculation of carbon contained in harvested timber after milling in period h, for product type k ($C_{MILL,h,k}$).
Description	The fraction of growing stock volume removed as roundwood for product type k
Source of data	(default values by region in Table 1.5 of the 1605(b) document)
Value applied	0.932
Justification	Values from Smith et al. (2006), weighted to account for the 5 year average harvest volumes by product in Ontario.
Measurement procedures	n/a

Comments	Variable used in both baseline (BSL) and project (PRJ) scenario

Data / Parameter	$r_{RND,k}$
Data unit	dimensionless
Used in	The calculation of carbon contained in harvested timber after milling in period h, for product type k ($C_{MILL,h,k}$).
Description	The ratio of industrial roundwood to growing stock volume removed as roundwood for product type k.
Source of data	(default values by region in Table 1.5 of the 1605(b) document)
Value applied	1.395
Justification	Values from Smith et al. (2006), weighted to account for the 5 year average harvest volumes by product in Ontario.
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario

Data / Parameter	$\Delta C_{EMITFOSSIL,t}$
Data unit	tC/yr
Used in	The calculation of the annual change in the carbon stored in harvested wood products (HWP), $\Delta C_{HWP,t}$
Description	Fossil fuel emissions from harvesting (logging and log transport) and processing of the various wood products.
Source of data	Calculated in equation 24 (Section 8.1) and equation 52 (Section 8.2)
Value applied	n/a
Justification	Fossil fuel emissions excluded from this project
Measurement procedures	n/a

Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$C_{EMITHARVEST,t}$
Data unit	tC/yr
Used in	The calculation of $\Delta C_{EMITFOSSIL,t}$
Description	Annual fossil fuel emissions associated with harvesting of raw material.
Source of data	Calculated in equation 25 (Section 8.1) and equation 53 (Section 8.2)
Value applied	n/a
Justification	Fossil fuel emissions excluded from this project
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$C_{EMITMANUFACTURE,t}$
Data unit	tC/yr
Used in	The calculation of $\Delta C_{EMITFOSSIL,t}$
Description	Annual fossil fuel emissions associated with the manufacturing of raw material.
Source of data	Calculated in equation 27 (Section 8.1) and equation 55 (Section 8.2)
Value applied	n/a
Justification	Fossil fuel emissions excluded from this project
Measurement procedures	n/a

Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	$C_{EMITTRANSPORT,t}$
Data unit	tC/yr
Used in	The calculation of $\Delta C_{EMITFOSSIL,t}$
Description	Annual fossil fuel emissions associated with the transport of raw material.
Source of data	Must be calculated after consideration of the transport distance from harvest to processing facility, and the means of transportation (after Heath et al. 2006 Supplementary). An example of calculation steps is provided in Section 8.1.
Value applied	n/a
Justification	Fossil fuel emissions excluded from this project
Measurement procedures	n/a
Comments	Variable used in both baseline (BSL) and project (PRJ) scenario, values may be different

Data / Parameter	LE_y
Data unit	tCO_2e/yr
Used in	The calculation of Market Leakage (Option 1)
Description	the project market leakage in year, y
Source of data	Calculated in Section 8.3.2, Option 1
Value applied	See Table/Annex/Worksheet ###.
Justification	Section 8.3.5 Market Leakage Option 3 used
Measurement procedures	n/a

Comments	

Data / Parameter	SE_y
Data unit	tCO_2e/yr
Used in	The calculation of Market Leakage (Option 2)
Description	The project market leakage in year, y
Source of data	Calculated in Section 8.3.2, Option 2
Value applied	n/a
Justification	Section 8.3.5 Market Leakage Option 3 used
Measurement procedures	n/a
Comments	

Data / Parameter	MLF_y
Data unit	unitless
Used in	Calculation of LE_y in year, y
Description	The project market leakage
Source of data	Calculated in Section 8.3.2
Value applied	18%
Justification	Section 8.3.5 Market Leakage Option 3 used
Measurement procedures	n/a
Comments	

Data / Parameter	$BC_{hv,n}$

Data unit	tCO_2e/yr
Used in	Calculation of SE_y
Description	The estimated average baseline amount of onsite carbon harvested in reporting period, n (prior to delivery to a mill).
Source of data	Calculated in Section 8.3.2
Value applied	n/a
Justification	Section 8.3.5 Market Leakage Option 3 used
Measurement procedures	n/a
Comments	

Data / Parameter	$AC_{hv,n}$
Data unit	tCO_2e/yr
Used in	Calculation of SE_y
Description	The actual onsite carbon harvested in reporting period, n (prior to delivery to a mill).
Source of data	Calculated in Section 8.3.2
Value applied	n/a
Justification	Section 8.3.5 Market Leakage Option 3 used
Measurement procedures	n/a
Comments	

Data / Parameter	$ER_{y,GROSS}$
Data unit	tCO_2e/yr
Used in	Calculation of LE_y

Description	The gross difference in the overall annual carbon change between the baseline and project scenarios in year, y
Source of data	Calculated in equation 57
Value applied	See Table/Annex/Worksheet ###.
Justification	Calculated in Equation 57
Measurement procedures	n/a
Comments	

Data / Parameter	**ER_y**
Data unit	tCO_2e/yr
Used in	Calculation of VCU_y
Description	The net GHG emissions reductions and/or removals in year y (the overall annual carbon change between the baseline and project scenarios, net all discount factors except the permanence buffer)
Source of data	Calculated in equation 58
Value applied	See Table/Annex/Worksheet ###.
Justification	Calculated in Equation 58
Measurement procedures	n/a
Comments	

Data / Parameter	**VCU_y**
Data unit	tCO_2e/yr
Used in	Calculation of VCU_y

Description	Amount of Verified Carbon Units the project estimates are available for issuance and sale in year 'y'
Source of data	Calculated in equation 59
Value applied	See Table/Annex/Worksheet ###.
Justification	Calculated in Equation 59
Measurement procedures	n/a
Comments	

Data / Parameter	E_M
Data unit	%
Used in	The calculation of uncertainty factor (Section 8.5.3)
Description	An estimate of model error based on the relative area-weighted difference between of model-predicted values of carbon storage and those values measured in field plots
Source of data	Model output and field data
Value applied	See Table/Annex/Worksheet ###.
Justification	Calculated in Equation 60a
Measurement procedures	n/a
Comments	

Data / Parameter	E_I
Data unit	%
Used in	The calculation of uncertainty factor (Section 8.5.3)
Description	An estimate of Inventory sampling error calculated as the 90% confidence limit of the area-weighted differences between the

	model-predicted values of carbon storage and those values measured in field plots
Source of data	Model output and field data
Value applied	See Table/Annex/Worksheet ###.
Justification	Calculated in Equation 60c
Measurement procedures	n/a
Comments	

Data / Parameter	E_P
Data unit	%
Used in	The calculation of uncertainty factor (Section 8.5.3)
Description	An estimate of total project error based sum of the model and inventory error terms
Source of data	Model output and field data
Value applied	See Table/Annex/Worksheet ###.
Justification	Calculated in Equation 60f
Measurement procedures	n/a
Comments	

Data / Parameter	$ER_{y,ERR}$
Data unit	Unitless
Used in	Calculation of VCU_y
Description	The uncertainty factor calculated for year ‘y’ in Section 8.5.3
Source of data	Calculated in Section 8.5.3

Value applied	See Table/Annex/Worksheet ###.
Justification	Calculated in Section 8.5.3
Measurement procedures	n/a
Comments	

Data / Parameter	BR_y
Data unit	tCO_2e/yr
Used in	Calculation of VCU_y
Description	Estimated VCU-equivalent tCO2e issued to the VCS Buffer Pool in year, y
Source of data	Calculated using the latest version of the VCS AFOLU Non-Permanence Risk Tool
Value applied	See Table/Annex/Worksheet ###.
Justification	Calculated using the latest version of the VCS AFOLU Non-Permanence Risk Tool
Measurement procedures	n/a
Comments	

5.2 Data and Parameters Monitored

Data / Parameter	$A_{PRJ,i}$
Data unit	Ha
Used in	Various equations in equation #32-60
Description	Area of forest land in polygon, i
Source of data	Monitoring of polygons and stand boundaries must be done preferably using a Geographic Information System (GIS), which

	allows for integrating data from different sources (including GPS coordinates and Remote Sensing data).
Value applied	###
Justification	Area of the property according to land title records and geospatial files.
Measurement procedures	n/a
Comments	

Data / Parameter	$A_{p,l,t}$
Data unit	m^2
Used in	Calculation of mean aboveground biomass B_{AG} and DOM_{SNAG} in Section 9.3.2 and 8.2.3.
Description	Area of sample plot in polygon, i, at time, t
Source of data	Recording and archiving of size of sample plots
Value applied	See inventory
Justification	Inventory sampling procedures
Measurement procedures	n/a
Comments	

Data / Parameter	$DBH_{,t}$
Data unit	cm
Used in	Calculation of mean aboveground biomass BAG in Section 9.3.2 and 8.2.3.
Description	Diameter at breast height measured for each tree in the sample plots at time, t
Source of data	Field measurements in sample plots

Value applied	See inventory
Justification	Field measurements in sample plots
Measurement procedures	Typically measured at 1.3m height above ground. Measure all trees above minimum DBH (5 cm) in the sample plots that result from the IFM project activity
Comments	

Data / Parameter	$Height_{,t}$
Data unit	m
Used in	Calculation of mean aboveground biomass B_{AG} in Section 9.3.2 and 8.2.3.
Description	Tree height measured for each tree in the sample plots at time, t
Source of data	Field measurements in sample plots
Value applied	See inventory
Justification	Field measurements in sample plots
Measurement procedures	n/a
Comments	

Data / Parameter	$L_{,t}$
Data unit	m
Used in	Calculation of mean mass of DOM_{LDW} in Section 9.3.2 and 8.2.3
Description	Length of the transects to used determine volume of lying dead wood in the sample plots at time, t (default 100m)
Source of data	Field measurements

Value applied	See inventory
Justification	Field measurements
Measurement procedures	n/a
Comments	

Data / Parameter	$d_{n,t}$
Data unit	cm
Used in	Calculation of mean mass of DOM_{LDW} in Section 9.3.2 and 8.2.3.
Description	Diameter of each piece n of dead wood along the transects in the sample plots at time, t
Source of data	Field measurements
Value applied	See inventory
Justification	Field measurements
Measurement procedures	Measured using the line-intersect method (Section 9).
Comments	

Data / Parameter	$D_{LDW,c,i,t}$
Data unit	tdm/m^3
Used in	Calculation of mean mass of DOM_{LDW} in Section 9.3.2 and 8.2.3.
Description	Density of dead wood in density class, c along the transect in polygon, i, at time, t
Source of data	Field measurements
Value applied	See inventory

Justification	Field measurements
Measurement procedures	Measured using the line-intersect method (Section 9).
Comments	

Data / Parameter	$N_{,t}$
Data unit	unitless
Used in	Calculation of mean mass of DOM_{LDW} in Section 9.3.2 and 8.2.3.
Description	Total number of wood pieces intersecting transects in the sample plots at time, t
Source of data	Field measurements
Value applied	See inventory
Justification	Field measurements
Measurement procedures	Measured using the line-intersect method (Section 9).
Comments	

Data / Parameter	$B_{AG,i,t}$
Data unit	tdm/ha
Used in	Calculation of carbon stocks in above- and belowground living tree biomass in equations 28b & 28c, Section 8.2.3.
Description	Average total aboveground biomass in polygon, i, for year, t
Source of data	Calculated from $Height_{i,t}$, $DBH_{i,t}$, and $A_{p,i,t}$
Value applied	See inventory
Justification	Calculated from $Height_{i,t}$, $DBH_{i,t}$, and $A_{p,i,t}$

Measurement procedures	n/a
Comments	Calculated

Data / Parameter	$B_{BG,i,t}$
Data unit	tdm/ha
Used in	Calculation of carbon stocks in above- and belowground living tree biomass in equations 28b & 28c, Section 8.2.3.
Description	Average total belowground biomass in polygon, i, for year, t
Source of data	Estimated from $B_{AG,i,t}$
Value applied	See inventory
Justification	Estimated from $B_{AG,i,t}$
Measurement procedures	n/a
Comments	Estimated

Data / Parameter	$B_{TOTAL,i,t}$
Data unit	tdm/ha
Used in	Calculation of carbon stocks in above- and belowground living tree biomass in equation 28c, Section 8.2.3.
Description	Average total live biomass in polygon, i, for year, t
Source of data	Calculated from $B_{AGi,t}$ and $B_{BGi,t}$
Value applied	See inventory
Justification	Calculated from $B_{AGi,t}$ and $B_{BGi,t}$
Measurement procedures	n/a
Comments	Calculated

Data / Parameter	$DOM_{LDW,i,t}$
Data unit	tdm/ha
Used in	Calculation of carbon stocks in dead organic matter (equation 28e, Section 8.2.3)
Description	Average mass of dead organic matter contained in lying dead wood in polygon, i, year, t
Source of data	Calculated from $L_{,i,t}$, $d_{n,i,t}$, $D_{LDW,c,i,t}$, and $N_{i,t}$
Value applied	See inventory
Justification	Calculated from $L_{,i,t}$, $d_{n,i,t}$, $D_{LDW,c,i,t}$, and $N_{i,t}$
Measurement procedures	n/a
Comments	Calculated

Data / Parameter	$DOM_{SNAG,i,t}$
Data unit	tdm/ha
Used in	Calculation of carbon stocks in dead organic matter (equation 28e, Section 8.2.3)
Description	Average mass of dead organic matter contained in standing dead wood in polygon, i, year, t
Source of data	Calculated from $Height_{i,t}$, $DBH_{i,t}$, and $A_{p,i,t}$ of dead trees measured in sample plots described in Section 9
Value applied	See inventory
Justification	Calculated from $Height_{i,t}$, $DBH_{i,t}$, and $A_{p,i,t}$ of dead trees measured in sample plots described in Section 9
Measurement procedures	n/a
Comments	Calculated

Data / Parameter	$f_{PRJ,NATURAL,i,t}$
Data unit	unitless; $0 < f_{PRJ,NATURAL,i,t} < 1$
Used in	Equation 35, Section 8.2
Description	The annual proportion of biomass that dies from natural mortality in polygon, i, year, t.
Source of data	Permanent sample plots in similar stand types, literature reports, and inventory data
Value applied	n/a
Justification	Value is contained within CBM-CFS3
Measurement procedures	n/a
Comments	

Data / Parameter	$f_{PRJ,HARVEST,i,t}$
Data unit	unitless; $0 < f_{PRJ,HARVEST,i,t} < 1$
Used in	Equation 36, Section 8.2
Description	The proportion of biomass removed by harvesting from polygon, i, in year, t
Source of data	Permanent sample plots in similar stand types, literature reports, and inventory data
Value applied	n/a
Justification	Value is contained within CBM-CFS3
Measurement procedures	n/a
Comments	

Data / Parameter	$f_{PRJ,DAMAGE,i,t}$
Data unit	unitless; $0 < f_{PRJ,DAMAGE,i,t} < 1$
Used in	Equation 37, Section 8.2
Description	The proportion of additional biomass removed for road and landing construction in polygon, i, year, t
Source of data	Permanent sample plots in similar stand types, literature reports, and inventory data
Value applied	n/a
Justification	Value is contained within CBM-CFS3
Measurement procedures	n/a
Comments	

Data / Parameter	$f_{PRJ,BLOWDOWN,i,t}$
Data unit	unitless; $0 < f_{PRJ,DAMAGE,i,t} < 1$
Used in	Equation 40, Section 8.2
Description	The annual proportion of live aboveground tree biomass subject to blowdown in polygon, i, year, t.
Source of data	Permanent sample plots in similar stand types, literature reports, and inventory data
Value applied	n/a
Justification	Value is contained within CBM-CFS3
Measurement procedures	n/a
Comments	

Data / Parameter	$f_{PRJ,SNAGFALLDOWN,i,t}$

Data unit	unitless; $0 < f_{PRJ,SNAGFALLDOWN,i,t} < 1$
Used in	Equation 40 & 44, Section 8.2
Description	The annual proportion of snag biomass in polygon, i, year, t, that falls over and thus is transferred to the LDW pool.
Source of data	Permanent sample plots in similar stand types, literature reports, and inventory data
Value applied	n/a
Justification	Value is contained within CBM-CFS3
Measurement procedures	n/a
Comments	

Data / Parameter	$f_{PRJ,lwDECAY,i,t}$
Data unit	unitless; $0 < f_{PRJ,lwDECAY,i,t} < 1$
Used in	Equation 41, Section 8.2
Description	The annual proportional loss of lying dead biomass due to decay, in polygon i, year, t,
Source of data	Permanent sample plots in similar stand types, literature reports, and inventory data
Value applied	n/a
Justification	Value is contained within CBM-CFS3
Measurement procedures	n/a
Comments	

Data / Parameter	$f_{PRJ,SWDECAY,i,t}$
Data unit	unitless; $0 < f_{PRJ,SWDECAY,i,t} < 1$

Used in	Equation 444, Section 8.2
Description	The annual proportional loss of snag biomass due to decay, in polygon, i, year, t.
Source of data	Permanent sample plots in similar stand types, literature reports, and inventory data
Value applied	n/a
Justification	Value is contained within CBM-CFS3
Measurement procedures	n/a
Comments	

5.3 Monitoring Plan

The project monitoring plan will monitor changes in carbon stocks related to the calculation of VCU's prior to each verification. This will be achieved by monitoring changes in forest inventory conditions (relative to the valid starting forest inventory) using periodic re-measurement of permanent sample plots using both traditional ground-based measurements and updated aerial LiDAR-based data. Forest inventory conditions will be compared against modeled carbon stocks and an uncertainty factor will be calculated.

PFLP is a Canadian owner of private forestland that seeks to invest in nature through land acquisition and implementation of carbon projects. Daniel Andres, Vice President, is responsible for overall management of the Painted Forest property. All operational monitoring activating are managed by Daniel Andres. Ostrom Climate is responsible for all carbon project data analysis, modelling, project reporting, technical oversight, and advice.

Project Monitoring falls under three main categories:

1. **Annual inventory change monitoring**

PFLP is responsible for monitoring significant spatial changes (greater than 4 ha) to the project area and notifying Ostrom Climate if significant change is detected. Annual inventory change monitoring is done by field reconnaissance observations (ground and helicopter) and analysis of satellite data for changes in landcover (Sentinel data) and fire activity (MODIS). Detection of significant spatial changes will prompt updates to spatial database and project inventory.

2. **Leakage Monitoring**

Ostrom Climate will complete and document the following:

A. Activity shifting leakage (at every verification)

B. Annual market leakage calculations (at every verification)

Activity shifting leakage will be reported during each verification by updating the forest management activities on other regional PFLP properties, as per data requirements in section 4.3.

Market leakage calculations will be updated each verification as per the data requirements of Section 4.3.

3. **Forest Inventory Monitoring**

PFLP has established and maintains a network of spatially systematic permanent sample plots throughout the project area. The plots were initially established in the summer of 2022 by Northwinds Environmental and used to develop the valid starting forest inventory. PFLP also collected aerial LiDAR data for the entire project area in summer and fall of 2022 which was used by Tesera to refine the starting inventory. Plots will be re-measured prior to each validation using a combination of traditional field measurements and using updated LiDAR data. Details on the statistical methods and accuracy of the LiDAR plot measurements are detailed in the Tesera Methodology and reporting documents (appendix).

The QA/QC blind checks of 10% of plots has been completed by the validator and all checked plots meet the required precision thresholds.

The initial uncertainty factor for the project inventory was calculated to be XX% and the overall project error was calculated to be XX%. Additional technical details related to the project forest inventory and associated statistical methods can be found in the Tesera HRIS documentation (appendix).

Plot network Development and Data chain of custody:

The permanent sample plot network was established consistent with the process in VM0012 v1.2:

A. *Stratification for field plot sampling*: Plot stratification was completed by Tesera using existing plot data from a previous inventory completed in 2013 by Quercus Algoma Corporation. Seven strata were identified for sampling with a total of 125 plots as described in the *Ostrom Field Sampling SOP* document (appendix). A statistical estimate of population variance from the 2013 plots indicated that 59 plots would be required to produce a forest inventory within 10% of the value of the mean with a 90% confidence interval, so the planned sampling intensity of 125 plots is expected to be sufficient for the project. Tesera will further segment the project area into analysis units (AU) for the development of the final forest inventory. The project may elect to establish additional field plots in the future to improve inventory accuracy or coverage.

B. *Plot locations*: Plots were located using a spatially systematic (aka grid pattern) approach. This plot design approach is discussed in detail in Cochrane 1977. An office review was conducted to identify plot locations that were likely to land in areas of permanent stratifiable non-forest (e.g. lakes) and an alternative plot list was provided for field crews to use once they had verified that the original location was indeed non-forest. This method of pre-selected alternative plots was done to ensure sufficient spatial coverage and to ensure fieldwork efficiency (avoid time consuming travel to a plot location only to discover it is located in water and then drop the plot and not collect any data for the day) given the many lakes throughout the property. Each plot is geolocated by field crews as per Tesera *High Resolution Forest Inventory Methodology Report.* Technical details on design of plot grid can be found in the Tesera *High Resolution Forest Inventory Plot Sample Design* document (appendix).

C. *Plot design:* The field plots are designed as fixed area permanent sample plots. All field procedures are documented in *Ostrom Field Sampling SOP*. Field measurements will capture data for both standing and laying tree biomass.

D. *Field data chain of custody:* Field data is digitally collected by Northwinds Environmental which adheres to all professional regulations and codes of conduct for forest professionals in the province of Ontario. Northwinds has documented their fieldwork QA/QC procedures in XXX (appendix). Upon completion of digital field data collection, Northwinds crew members and project manager will conduct an office review of all data and then physically print, date, and sign all field cards and convert to pdf for permanent custody by PFLP. If any future data discrepancies arise between digital versions of data and signed pdf version, then the signed pdf version will take primacy.

E. *Precision*: The plot network has a design target of establishing sufficient plots such that the estimate of carbon stocks across all analysis units will lie within 10% of the value of the mean at the 90-percent confidence level.

F. *Measurement and Data Analysis techniques*: All field measurement procedures are documented in the Ostrom Field Measurement SOP version 1.0 (appendix). This document may be refined periodically and any new plots will follow protocols from the latest version of the document. Plot data is then integrated into the Tesera Forest Inventory from which stand level carbon modelling can be completed.

The relevant equations are included in Section 4.

G. *Plot re-measurement:* Field plots will be re-measured each within 5 calendar years of the last measurement. Re-measurement may be done using a combination of traditional field-based re-measurement and LiDAR updates. The field-based re-measurement methods will be found in the latest Ostrom Fieldwork SOP document. New plots may be established in the event of disturbance or loss of original plots.

H. *Quality Assurance/Quality Control for Field Measurements:* The Ostrom Fieldwork SOP document provides detailed instructions for completing accurate and repeatable field plot measurements. Northwind's field crews are trained in all technical aspects of forest measurement techniques in the province of Ontario and are supervised by registered forestry professionals (a regulated profession bound by a statutory code of ethics in Ontario). Accreditation and training records of Northwinds crew members are available on file with PFLP. The "hot-check" QA/QC procedures described in VM0012 were documented and carried out by Northwinds staff and an independent 3rd party contractor. The primary assessment of fieldwork QA/QC was done using "cold checks" of a minimum of 10% of all measured plots. A complete report on the results of field QA/QC was completed by Northwinds and contains all QA/QC results (see appendix). The QA/QC was found to meet all VM0012 minimum thresholds.

Leakage Monitoring Procedure

Activity shifting leakage is monitored and reported at each verification, as per methods outlined in section 4.3. PFLP will assess and report on commercial harvesting on any other properties owned or controlled by PFLP in the region, if any, and will demonstrate that there is low or no risk of activity shifting leakage.

Market leakage is not specifically monitored by the project; however, a market leakage rating is calculated on an annual basis at each verification, following the procedures outlined in Section 4.3.

Frequency of Monitoring.

Permanent sample plots will be re-measured (or updated using new LiDAR data) within 5 calendar years of last measurement.

Spatial inventory and property monitoring is undertaken annually and reported at each verification.

Leakage monitoring is reported on an annual basis at each verification.

Use of monitoring data to update carbon stock calculations

Data gathered through the monitoring process will be used for:

A. Updating the project forest inventory and related modeling and monitoring stratification as per section xx.
B. Updating leakage calculations in Section 4.
C. Updating error estimates used in the calculation of the uncertainty factor as per section xx.
D. Updating and validating calculations of carbon stocks in Section xx.

Updating of Monitoring Polygons (Analysis Units)

The ex-post stratification and spatial assignment of analysis units shall be updated at minimum prior to each verification, for any of the following reasons:

A. Errors in the inventory from field sampling or other sources. Any non-*de-minimis* updates due to errors in the inventory will require recalculation of both the annual project emissions and the annual baseline emissions for the current monitoring period prior to the next verification.
B. Changes to forest inventory attributes from monitoring of natural disturbance, planned/unplanned project activities or general inventory data refinements. Updates will be made for any monitored event (at minimum >4 ha) that affects the criteria used to define an analysis unit for the project forest inventory.

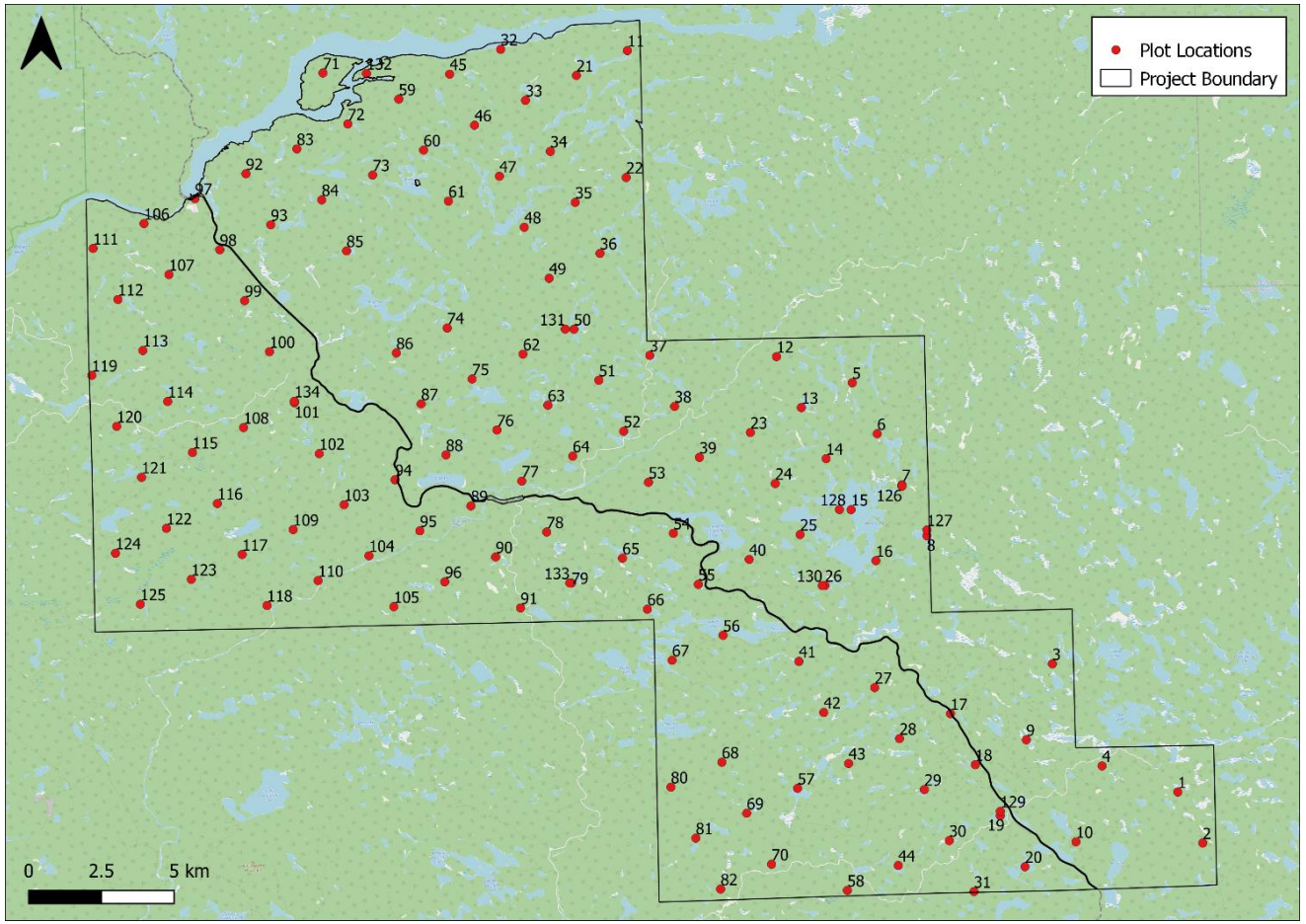


Figure 6. 2022 Permanent Sample Plot locations

APPENDIX

Use appendices for supporting information. Delete this appendix (title and instructions) where no appendix is required.