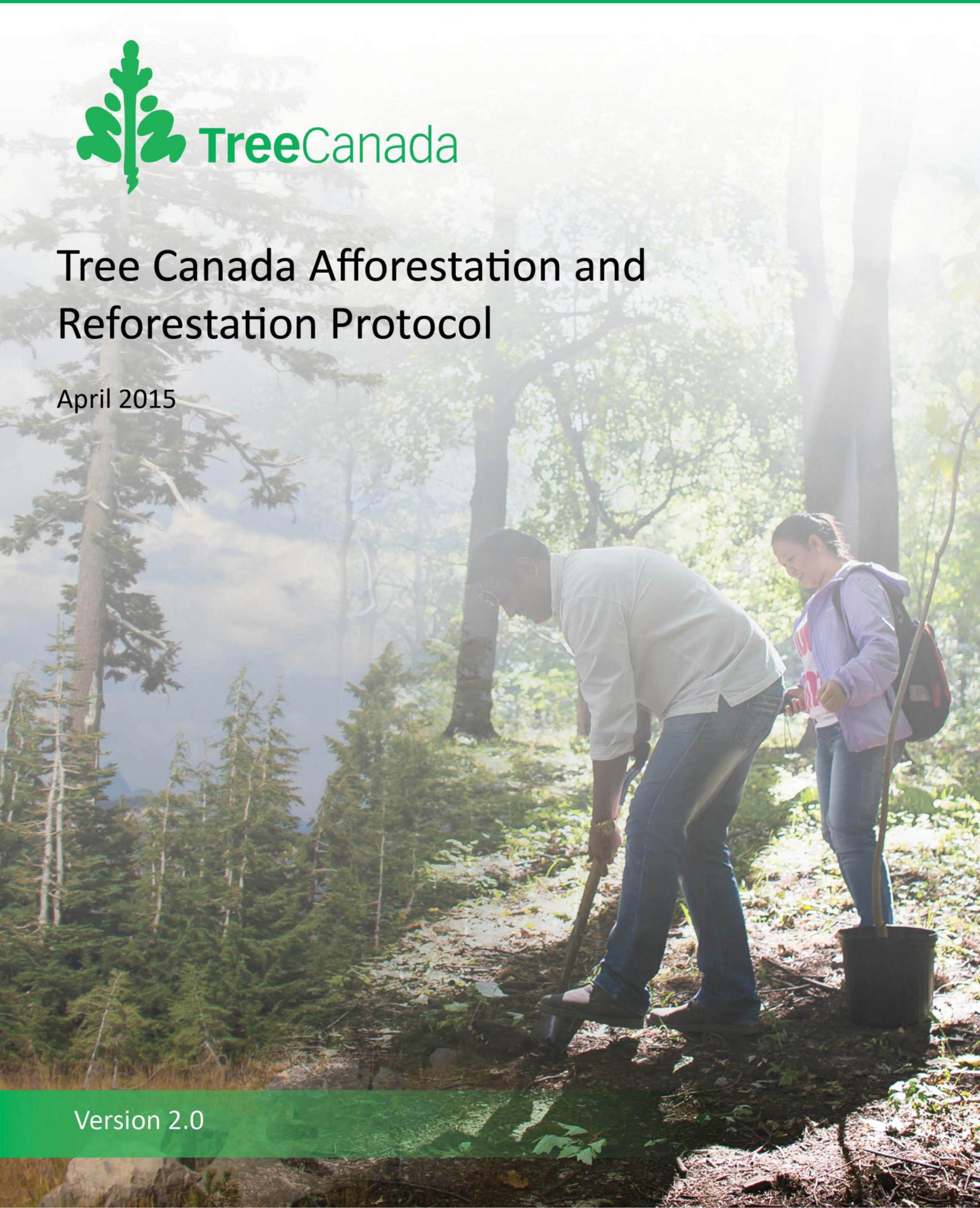
Tree Canada Afforestation and Reforestation Protocol

April 2015



Version 2.0

Tree Canada Afforestation and Reforestation Protocol

A Protocol for the Eligibility and Measurement of Tree Canada Carbon Offset Projects

Prepared in Collaboration with:

Dr. Jeremy Williams
ArborVitae Environmental Services Ltd.

Etienne Green, R.P.F.
Tree Canada Project Manager

Cédric Bertrand, ing.f.
Former Tree Canada Project Manager

Tree Canada Board of Directors: Dr. Gary Bull, Peter Johnson, R.P.F. &
Timo Makinen, P.Eng

Version 2.0
April 2015

TreeCanada

Table of Contents

List of Tables

1.0 Introduction

Tree Canada is a not-for-profit, charitable organization established in 1992. Under the direction of a volunteer Board of Directors, and with the assistance of numerous Community Advisers, provincial and community organizations, Tree Canada provides education, technical assistance, resources and financial support to encourage Canadians to plant and care for trees.

Since 1992, Tree Canada has planted 80 million trees, greened over 600 schoolyards and helped establish urban forest programs in hundreds of communities, making it Canada's largest not-for-profit tree organization.

One of the reasons that Tree Canada was founded in 1992 was to plant trees to "…counter the effects of climate change." From there, the organization developed programs and information detailing the relationship between trees and greenhouse gas (GHG) sequestration. Two key Board members, *Dr. Nigel* Roulet of McGill University and *Dr. Bruce Freedman* of Dalhousie University, developed *Planting Trees for Carbon Credits* and *The Role of Trees in the Reduction of Atmospheric* CO_2, innovative information pieces. In 2005, Tree Canada launched *Grow Clean Air*, which formalized a program of calculating the theoretical amount of CO_2 sequestered by the "*average*" Canadian tree. Programs around "carbon neutral event," "company" and "organization" were developed. Today, over 100 meetings, events and conferences have offset their carbon emissions with tree planting with Tree Canada.

In 2011, Tree Canada established its first carbon plantation in partnership with TD Bank, and Munsee-Delaware Nation. The project was successfully verified in 2012 against version 1.1 of Tree Canada's Standard, making it the first carbon project to generate offsets under the Standard. This revised Protocol (version 2.0) builds on Tree Canada's history of carbon-related programming and the experience Tree Canada has gained since version 1.1 was released.

Tree Canada plants and maintains trees in both rural and urban sites. It is estimated that about 85% of Tree Canada's trees are planted in rural areas, with the other 15% being planted in urban or peri-urban areas. Agreements are signed with companies who pay Tree Canada to plant and care for a certain quantity of trees in a certain area. In most cases, Tree Canada retains the right to the carbon from the trees.

Global interest in carbon offset projects is steadily increasing, with the subsequent demand for the validation and verification of trees planted by Tree Canada growing as well. As part of this trend, individuals, event organizers, organizations and companies increasingly see value in Tree Canada being able to provide greater assurance of the GHG impact of its plantings. Comparisons of offset programs are continually being made by various institutes to assist customers seeking reliable ways to offset GHG emissions. In response to these customer and client demands, Tree Canada released the first version of this Protocol (1.0). One of the primary purposes was to increase the rigour of the validation and verification of the carbon offsets created by its plantings. Since then, Tree Canada has received many inquiries related to its Protocol and has revised the Protocol in part to make it more widely applicable, including being relevant to projects undertaken by different organizations throughout Canada. At the same time, the majority of the carbon markets in Canada remain voluntary, and there is a need for a protocol that combines rigour with applicability. This Version 2.0 of the Protocol was created with the goal of meeting this need, while remaining relevant to the typical types of planting projects that Tree Canada undertakes.

Two of the major project types that Tree Canada undertakes are:

A. Afforestation: Planting trees on land that has been used for a purpose other than forestry — most often old agricultural fields. These projects tend to be classic Afforestation projects — planting trees on sites that are presently grassed or are covered in other non-woody vegetation. The ownership of these lands includes private owners and municipalities.

B. Reforestation: Tree Canada also plants sites that have recently lost their forest cover as a result of natural disturbance, such as fire, wind, flooding or insect infestation. The sites that are planted are often on municipal lands, but have included private, Crown and First Nation lands. The most challenging aspect of defining these projects from a carbon offset perspective is defining a realistic baseline (i.e. forecast what would have happened on the site in the absence of the project).

Afforestation and Reforestation were recognized in Article 3.3 of the Kyoto Protocol as activities which can generate carbon offset credits, and there are numerous standards in place that can be used to assess the amount of carbon offset credits generated from these types of projects. A tree planting project is considered an Afforestation project if there is a land use change, implying that Afforestation projects can only take place on lands that are, prior to the project, used for purposes other than supporting a forest. In contrast, reforestation projects involve no change in land use — they involve planting trees on an area that was forested and then lost all or most of its forest cover. Because Afforestation and reforestation projects are similar in most respects, they are covered in section 3 of this Protocol document.

Tree Canada also undertakes individual tree planting and park naturalization projects in urban areas. Version 1.1 contained a separate section of the Protocol that was applicable to these projects; in this revision, Tree Canada has decided to create two separate standards documents – this protocol version (2.0) for Afforestation and Reforestation projects, and a second document for urban tree carbon projects to be released.

This Protocol is structured according to the August 2008 draft of *Environment Canada's Guide for Protocol Developers*, which has not been updated. That guide was intended to provide direction for organizations that wished to develop a base Protocol for Canada's Greenhouse Gas (GHG) Offset System, which remains in a developmental phase.

This Protocol (2.0) has benefitted from an August 2008 draft of an example *Afforestation Protocol* prepared by the Canadian Forest Service (CFS). This document is available upon request from the Canadian Forest Service. Elements from the Clean Development Mechanism (CDM) and World Wildlife Fund (WWF) Gold Protocol requirement, as well as from the California Climate Action Registry (CCAR) forest carbon project Protocol, are also included in this version of the Protocol (2.0)

This Protocol is intended to provide guidance to Tree Canada in planning and developing projects, preparing its contractual arrangements with field contractors and project sponsors, monitoring the projects, and calculating the amount of offset credits that are generated. The Protocol will discuss monitoring and, to a lesser extent, verification, and may be used to assist third-party verifiers that may be engaged by Tree Canada to verify the offsets created from its projects.

2.0 Protocol Identification and Contact Details

2.1 Name of the Protocol

Tree Canada Afforestation and Reforestation Protocol

2.2 GHGs that will be Reduced/Removed

A project that qualifies under this Protocol will create net removals of carbon dioxide from the atmosphere (CO_2 sequestration). Methane and nitrous oxide emissions from Tree Canada projects will generally be minor and need not be considered in the accounting of GHG emissions in this Protocol. Where the pre-project use of the land (i.e. the baseline, in most cases) included fertilization, this Protocol has the option of accounting for this reduction in emissions or omitting consideration of it — omitting will understate the project benefits.[1, 2]

2.3 Intended Users of the Protocol

This Protocol is written for Tree Canada, which develops Afforestation and reforestation projects. This Protocol is intended to provide guidance to Tree Canada staff, Community Advisers and project implementers and verifiers in the design and implementation of Tree Canada's tree planting projects.

As this document is intended to provide a basis for the documentation of Tree Canada's urban tree planting projects, the Offset System Program Authority and third-party certified verifiers will also be using it as the basis for registration and subsequent verification of reductions/removals.

[1] Clean Development Mechanism (CDM). 2007. Estimation of direct nitrous oxide emission from nitrogen fertilization — Draft methodological tool CDM – A/R WG Fifteenth meeting Report Annex 06.

[2] Intergovernmental Panel on Climate Change (IPCC). 2006. N_2O Emissions from Managed Soils, and CO_2 Emissions from Lime and Urea Application. Chapter 11: of 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Edited by Simon Eggleston, Leandro Buendia, Kyoko Miwa, Todd Ngara, and Kiyoto Tanaba

2.4 Lead Protocol Developer

Organization:	Address:	
ArborVitae Environmental Services Ltd.	3 Pine Crescent, Toronto, ON M4E 1L1	
Name:	City:	
Dr. Jeremy Williams	Toronto	
Title:	Province:	Postal Code:
President	Ontario	M4E 1L1
Email address:	Website:	
jeremy.w@sympatico.ca	www.avesltd.ca	
Telephone Number:	Fax Number:	
416 694-8123		
Type of Entity		
Consultant		

2.5 Other Protocol Developers

The Tree Canada Afforestation and Reforestation Protocol 2.0 was reviewed by Michael Rosen (President), Etienne Green (Project Manager), Cédric Bertrand (Project Manager), some members of the Tree Canada Board (Gary Bull, Timo Makinen, and Peter Johnson).

2.6 Initiating Agency

Organization	Address	
Tree Canada	470 Somerset St. West	
Name	City	
Mike Rosen	Ottawa	
Title	Province	Postal Code
President	Ontario	K1R 5J8
Email Address	Website	
mrosen@treecanada.ca	www.treecanada.ca	
Phone Number	Fax Number	
613-567-5545	613-567-5270	
Rational for Protocol Development		
Tree Canada was originally launched in part to help address Canada's GHG footprint through the planting and maintenance of trees. Carbon markets and related institutions have now evolved to the point that it makes sense for Tree Canada to develop a program of third party verified carbon credit development from its tree planting activities. There is growing interest from corporate clients, the public and partners for this service. The purpose of this program is to develop a verified standards package for clients, who have increasingly expressed interest in having this service available. The Protocol is also intended to assist other parties, such as potential donor companies and project aggregators, as well as third- party verifiers. The Protocol will help to ensure that Tree Canada's projects meet the measurement, monitoring and GHG quantification requirements of Canada's developing Offset System		

2.7 Development Approach

2.7.1 Approach Taken to Develop the Protocol

The development of this Protocol was initiated by Tree Canada. A consultant, Dr. Jeremy Williams of ArborVitae Environmental Services Ltd., was hired to help develop the Protocol. Discussion with Tree Canada staff and Board led to the decision to base the Protocol on a draft Afforestation Protocol prepared by the CFS. The CFS Protocol was developed according to Environment Canada's draft *Guide to Quantification Methodologies* and Protocols and the specifications and directives of the International Organization for Standardization (ISO) 14064-2:2006.

The Protocol (2.0) also considers the Protocol for Afforestation Projects (version 1, Sept 2007) prepared for the Alberta government and the on-going development of version 3 of the California Climate Action Registry's Forest Project Protocol (final draft released for public comment on June 22, 2009). This Protocol is also informed by the discussions related to the Canada/U.S. harmonized forest carbon standard development.

A timeline of the development of this Protocol is listed below in Section 2.7.2

2.7.2 Building on Existing Protocols

Date	Purpose & Objective	Results
April 1 – May 8, 2009	Development of draft Protocol by Dr. Williams	Draft Protocol submitted to Tree Canada for review.
May 9 – June 10, 2009	Tree Canada staff and some Board members reviewed the draft and provided comments	Comments incorporated by Dr. Williams
June 11 – Aug 7, 2009	External Review of the Protocol by four reviewers: Karen Haugen- Kozyra and Tanya Maynes, Climate Change Central, Edmonton, Alta., Brian Smart, Smart Forest Biomass, B.C.; Mark Johnston, Saskatchewan Research Council, Sask., and a team led by Jean- Robert Wells, ing., MGP, Research Chair in Éco-Conseil, Université du Québec, Chicoutimi, Que.	Comments incorporated by Dr. Williams
August 10 – September 2009	Translate, design and print/pdf Protocol.	
September 23, 2009	Release of Protocol 1.0.	

February 2013	Tree Canada requested a proposal from Jeremy Williams of ArborVitae Environmental Services Ltd to develop a revision to the Afforestation and reforestation Protocol version 1.1, prepared and released in 2009	Dr. Williams prepared a proposal which was accepted by Tree Canada.
March, 2013	Tree Canada requested Dr. Williams review version 1.1 of the Protocol and identify where major revisions should be made.	
August 2014	Development of Draft Protocol by Jeremy Williams	Dr. Williams prepared a draft Protocol submitted to tree Canada for review
April 14, 2015	Internal Review of Draft Protocol by Tree Canada	Etienne Green, R.P.F. reviewed the draft Protocol and discussed comments with Dr. Williams
April 22, 2015	Release of Tree Canada Afforestation and Reforestation Protocol 2.0	
April 14, 2015	Internal Review of Draft Protocol by Tree Canada	Etienne Green, R.P.F. reviewed the draft Protocol and discussed
June, 2015	Translate design and print/pdf Protocol.	

2.7.3 Previous Protocols

Version 1.1 of this Protocol was based primarily on the draft Afforestation Protocol prepared by the CFS. This revision has taken into consideration several recent standards, including the Protocol for the Creation of Forest Carbon Offsets in British Columbia (version 1.0 - undated), California Climate Action Registry (CCAR) Forest Project Protocol version 3.3 (November 15, 2012), Version 3 of the Verified Carbon Standard (VCS) as well as the GHG project templates developed by the Canadian Standards Association.

2.7.4 Use of Good Practice Guidance

This Offset Protocol was developed in accordance with the Intergovernmental Panel on Climate Change Good Practice Guidance for Land Use, Land Use Change and Forestry (*IPCC GPG LULUCF, 2003*). Section 4.3 of the GPG LULUCF lists the guidance available for land use change and forestry projects. The scope of projects eligible under this Protocol follows GPG LULUCF, as do the methodologies prescribed for project boundaries, measuring and monitoring, data management, and quality assurance/quality control (QA/QC).

2.7.5 Continuous Improvement

Version 1 of this Protocol was developed to a level of stringency that was considered to appropriately balance the availability of data and factors needed to quantify emission reductions/sequestration, the cost of project specific measurements, monitoring and verification, the maintenance of credibility and minimization of the risk of overestimating the amount of sequestration or reduction of net emissions. Since Version 1 was released, forest offset standards in general have tended to become more rigorous, more comprehensive, and require measurement of pools that earlier would have been considered as options. Tree Canada has also benefitted from its experience in undertaking and having verified its first carbon project under this standard. These factors are among the drivers for the revision to Version 1 of this standard.

Tree Canada has brought its documentation, practices and procedures into greater conformity with the demands of this Protocol and the evolving nature of the offset systems. Tree Canada intends to develop a Practices Guideline for its planting program that would include guidance on verification procedures, when and how credits would be brought to market, and selling prices and conditions of sale.

3.0 Protocol for Tree Canada Afforestation and Reforestation Project

3.1 Protocol Scope and Requirements

The Tree Canada's Protocol covers two classes of net GHG emission removal projects— Afforestation projects and Reforestation projects (AR). AR Projects designed and implemented under the Tree Canada Protocol will achieve net GHG removals through the increase in carbon stocks held in above and belowground biomass of trees and shrubs. This Protocol will report the net GHG emission removals in tonnes of Carbon Dioxide equivalents (tCO_{2e}).

3.2 Project Eligibility

The Protocol allows for the Afforestation and reforestation of lands where project activities will increase the growth potential of trees. These lands must meet all of the criteria described below.

> ***P 1 -*** *The project area is greater than or equal to 1 hectare in size, with a minimum width of 20 metres, measured from tree-base to tree-base (stump to stump).*
>
> ***P 2 -*** *The project area does not fall into the category of wetlands.*
>
> ***P 3 -*** *The project area must be in good standing with all applicable legal and other regulatory requirements in the jurisdiction where the project is located.*

3.2.1 Afforestation

To demonstrate that an Afforestation project is within the scope of this Protocol, evidence must be provided in the Project Design Document (PDD) that the project will, through human intervention, establish a forest on an area that has not been forested for at least 20 years. The Afforestation project will convert open, non-forested land to forest. Projects will establish long term tree cover by planting stock, cuttings or seeding. Natural renewal, whether assisted or unassisted, is not permitted as a means of initiating a project.

The conversion of land to plantations or the rehabilitation of degraded industrial lands, such as mines or landfill sites are eligible.

The presence of pre-existing trees is allowed and should be accounted for using the SOP Tree Volume found in section 3.9.2 of this Protocol.

Eligible project areas must meet all of the following criteria:

> ***P 4 -*** *.Land was not forested during the twenty years prior to the project start date, any of the following evidence can be provided:*
>
> > ***P 4.1 -*** *Dated surveys or sampling results of the pre-project tree vegetation,*
> >
> > ***P 4.2 -*** *Historical photographs of the project site or,*
> >
> > ***P 4.3 -*** *Dated records of land management practices (e.g. tilling).*
>
> ***P 5*** *- Neither site drainage, prescribed burning nor windrowing are allowed to be undertaken for site preparation.*
>
> ***P 6 -*** *The trees established are capable of achieving a minimum height of five metres at maturity.*
>
> ***P 7 -*** *The trees will not be managed on a short-rotation (30 years or less) that culminates in a full harvest of timber.*
>
> ***P 8 -*** *The trees established are capable of achieving a minimum crown cover of 25% at maturity.*

3.2.2 Reforestation

To demonstrate that a reforestation project is within the scope of this Protocol, evidence must be provided in the PDD that the project will, through human intervention, re-establish a forest on areas significantly affected by forest cover loss. Projects will re-establish long lived tree cover by planting stock, cuttings or seeding. Lands should be classified as forest lands and have been largely or entirely killed by natural disturbance impeding the forest's ability to naturally regenerate. It must be described how the site will not be able to renew a forest. The disturbance must not be the result of intentional management activity or gross negligence on the part of the landowner/ manager. Projects are not permitted on forested land where the timber was harvested and the intended reforestation effort was not successful.

The presence of pre-existing trees is expected and should be accounted for using the SOP Tree Volume found in section 3.9.2 of this Protocol.

Eligible project areas must meet the following criteria:

> ***P 9 -*** *Lands are free of any legal requirement to reforest*.
>
> ***P 10 -*** *Lands must have fewer than 400 well-distributed healthy trees per hectare*[3]*, that are or can be expected to become free-to-grow, or on which a Registered Professional Forester or Forest Technician provides a written opinion that the natural regeneration of the area will not be sufficient to produce a forest with more than 50% tree crown cover at maturity.*
>
> ***P 11*** *- Lands must be classified as forest at some time within the past 20 years and at least 50% of the forest cover has been removed or heavily damaged by a natural disturbance.*
>
> ***P 12 -*** *The disturbance must have taken place at least ten years prior to project start date or, if it occurred less than ten years prior to project start, the following evidence shall be provided.*
>
> > ***P 12.1*** *- A written opinion by a registered professional forester or a silviculturist who is a qualified registered professional of a professional association that the site will not be able to renew for at least ten years.*
>
> ***P 13 -*** *The project site must not have been seeded or planted during the ten years prior to project initiation, unless the renewal operation was undertaken prior to the disturbance.*
>
> ***P 14 -*** *Lands may be salvage harvested; post-disturbance and prior to the project, however any live trees must represent a stocking of less than 50%.*
>
> ***P 15 -*** *Lands where fire has destroyed a young stand must have 10% or less tree canopy cover for at least ten years prior to the project start date. The fire must have occurred less than 20 years ago, and a registered professional forester or a silviculturist who is a qualified registered professional must provide a written opinion that the site will not be able to renew a forest for at least ten years.*

3.2.3 Carbon Offset Eligibility

Offset credits in tCO_2e created as a result of AR projects that meet the requirements of this Protocol may be issued on an ex ante basis or on an ex post basis, or as a combination. Ex ante credits are issued following the validation of the PDD and verification that the project activities have been implemented accordingly. Confirmation of the GHG emission reduction is scheduled in future monitoring events. Ex

[3] If 400 trees were evenly spaced on a hectare, they would be at an average spacing of approximately 5 x 5 m – the intent is that if the young trees are all clumped or found ingressing from the boundary of the project, and are all located along the side of the project area, the existing renewal will not form a forest, and an Afforestation project would be additional.

post offset credits are issued after monitoring events are completed and the GHG emissions reduction is confirmed. This Protocol does not specify one approach over the other.

3.2.4 Ownership

Project eligibility is not affected by the type of landowner, planting on private land and municipal land even crown land is eligible. The owner may be an individual, corporation or other legally constituted entity, city, county, provincial agency, or a combination thereof that has legal control of any amount of forest carbon within the Project Area. Multiple forest owners may participate. Control of the forest means the forest owner has the legal authority to effect changes to forest quantities, e.g., through timber rights or other forest management or land-use rights, fee simple ownership and/or deeded encumbrances, such as conservation easements. Since control of the forest may be associated with fee simple ownership or through one or more deeded encumbrances that exist within a project area, any one of which may convey partial control of the project's forest. Any unencumbered forest is assumed to be controlled by the fee simple owner.

> ***P 16 -*** *The project documentation shall include evidence to demonstrate clear title and legal ownership to the lands by the landowner.*

3.2.5 Project Proponent

Tree Canada is the Project Proponent in the projects that it undertakes. The Project Proponent is the entity that initiates and has lead responsibility for undertaking a project, and is responsible for all project reporting and attestations. The landowner owns the land on which the project is located. The project proponent will specify a Project Operator to implement and manage the project ensuring that the project is verified and regularly monitored, and liaising with a registry if the project becomes registered.

> **P 17 -** The project documentation shall provide description the project proponent and operator's credentials and justify their qualifications.

3.3 Project Requirements

3.3.1 Legal Requirements

A project must meet all legal and regulatory requirements throughout its duration. Regulatory compliance must be assessed as part of each verification assessment. Individual offset registries each have similar and potentially additional related requirements.

3.3.2 Project Start Date

Under this Protocol the start date of a project is the date at which project activities described in the PDD initiate and alter the vegetation or characteristics of a project area (e.g. site preparation). Afforestation and reforestation projects started in different years may be aggregated. Project aggregation is discussed in more detail In Section 3.3.7.

***P 18 -** The project Documentation shall demonstrate that Project start dates is on or later than January 1, 2008* [4]

***P 19 -** The starting dates of any aggregated projects must fall within five consecutive calendar years for them to be eligible for aggregation.*

3.3.3 Minimum Project Length

***P 20 -** The project documentation shall include a project minimum duration of 30 years.*

3.3.4 Permanence

Projects undertaken on public land, such as land owned by a municipal government is usually zoned as park, conservation reserve, or other classification that makes it very difficult to convert or develop the land to a use incompatible with retention of the forest cover, However, the permanence conditions on private lands are different and can present, over the medium and long-term, significant challenges. Under this Protocol the landowner will be required to sign a legally-binding agreement with the project proponent.

3.3.5 Terms of a Project Contract

The agreement provides direction and outlines the responsibilities of the landowner. The agreement will include terms to retain the area of the project in forest for a specified period of time, and monitoring and protection of the project on the part of the landowner.

***P 21 -** The project documentation shall include a legally binding agreement that transfers ownership of the carbon offsets to the project proponent and include the following;*

***P 21.1 -** The ownership of the carbon and associated offset credits;*

***P 21.2 -** The responsibilities and obligations of the Landowner to implement the project activities. 5*

***P 21.3 -** The responsibilities and obligations of the Tree Canada to implement the project activities.*

***P 21.4 -** The period of the agreement;*

***P 21.5 -** Provisions for dealing with reversals and early termination of the project by the* landowner;

[4] Turning the Corner: Canada's Offset System for Greenhouse Gases. Environment Canada. March 2008.

[5] In the case where the landowner is the Project Operator, the landowner shall sign an agreement with the purchaser of the carbon offsets. The legally binding agreement will have the same or similar provisions as in the paragraph above.

P 21.6 - *Provisions for notifying Tree Canada in the event of a land ownership transfer to a new owner.*

P 21.7 *Any financial considerations.*

P 22 - *The Project Documentation shall include evidence that the project land is subject to a legal agreement, easement or covenant that requires the land to be retained in a forested condition, or otherwise prevent the land being converted to a different use for the term of the project.*

3.3.6 Buffers

A reversal occurs when carbon that has been stored during a project is released into the atmosphere on an unplanned basis prior to the end of the project. Many biological and non-biological agents, both natural and human-induced, can cause reversals. Some of these agents cannot completely be controlled, such as natural agents like fire, insects, and wind. Other agents can be controlled, such as human activities like land conversion and over-harvesting.

Buffer pools cannot mitigate unexpected shortfalls in the forest growth that may also occur if the plantations grow more slowly than planned. Conservatism, monitoring effective reporting shall ensure GHG removals are not over estimated.   In the event of that plantations show lower yields, the proponent will be required adjust projections, remove shortcomings in offsets or implement additional project activities to meet the target growth. Buffer pools are established in order to minimize the risk of reversal from an unplanned event. It is required that the proponent establish a buffer for the project. This could take the form of one of the following three approaches:

P 23 - *The Project Documentation shall include an analysis of potential risks of reversal and identify implementable measures to mitigate reversal risks to provide a sufficient level of insurance.*

P 24 - *The project documentation will include evidence that a minimum 25%[6] buffer pool from the Net GHG removals is in place; one of the following mechanism must be demonstrated*

P 24.1- *Reserving the below-ground carbon stocks as assurance against reversals.*

P 24.2 - *Entering in a contractual agreement that will provide for a replacement of retired offset credits that might either be reversed due to a disturbance such as fire or harvesting.*

P 24.3 *- Purchasing, listing in a third party registry and retiring Carbon offsets from a separate carbon offset project.*

[6] The 25% was determined on the basis that it is judged to be sufficient to cover most reversals or shortfalls in anticipated offset production. It is noted that the risk assessment in Appendix A of version 3.3 of the California Protocol results in a requirement to "hold back" 25 - 30% of the available credits, using a 5% risk of wildfire, in the absence of an easement. This is in line with the 25% requirement in this Protocol.

3.3.7 Project Aggregation

Projects may be aggregated to improve cost effectiveness and pool risk while maintaining rigor in overall carbon inventory accounting. Projects can benefit through participation in an aggregate by meeting carbon inventory confidence standards across the aggregate, rather than within each project area. Similarly, verification of aggregated projects is considered across the broader population. An aggregate consists of two or more individual forest projects managed by the Project Proponent. Reforestation and Afforestation projects cannot be combined into a single aggregate. There is no limitation on the number of projects that may be grouped into an aggregate; however, to prevent any one project from disproportionately affecting the inventory statistics and having excessive influence on the composite sampling error, the following conditions apply:

***P 25 -** Project documentation shall demonstrate that for aggregates formed by more than two projects, none shall comprise more than 50 percent of the total combined area in an aggregate.*

***P 26 -** Project documentation shall demonstrate that for aggregates formed by two projects, none may comprise more than 70 percent of the total combined area in the aggregate.*

Administering an Aggregate

An aggregate may be treated as a large single project from the perspective of quality assurance and administration including verifications and monitoring. This will ensure that projects added to existing aggregates meet the standard, have solid information regarding the condition of the site prior to the project, and have appropriately quantified the amount of offsets they have produced to date it required

***P 27 -** Projects can only join an aggregate after they have undergone site visit verification. If the various projects in an aggregate are on lands owned by different entities, a contractual arrangement among the various landowners and the aggregator is required, as described in P 28 below.*

***P 28 -** Aggregate project documentation shall demonstrate that a contractual agreement is in place and addresses the following:*

> ***P 28.1 -** Description of services the aggregator will perform on behalf of the project owners with regards to project management.*
>
> ***P 28.2 -** Mechanism for sharing of costs, including costs of remediation that may be required to bring an individual project back into conformance with the project description document; Consideration of ownership of offsets and,*
>
> **P 28.3 -** Contributions to the buffer pool; Consideration of distribution of risk when some projects have sold credits on an ex ante basis and,
>
> **P 28.4 -** Consequences of contract termination or failure by the aggregator or a project owner; and

P 28.5 - The disposition of credits remaining in the aggregator account in the event of contract termination or failure on behalf of the aggregator and/or a project owner.

3.4 Description of Additionality and Definitions of Baseline Scenarios

The baseline scenario is the most reasonable estimate carbon flux in the absence of the project. The description and selection of the baseline scenario should be done by considering what changes in land uses are likely to occur during the project timeframe. This involves a consideration for drivers of land use change patterns within the project region, the nature and strength of drivers of land use change, as well as specific attributes of the site that will influence its future use. The project region is defined as the spatial extent upon which attributes or trends have meaningful impacts to land use of the project area.

The identification of baseline scenarios for Afforestation and Reforestation projects are needed to demonstrate that the implementation of project activities would not occur in the absence of carbon finance and can therefore be considered additional. These guidelines are consistent with the *Intergovernmental Panel on Climate Change Good Practice Guidance for Land Use, Land Use Change and Forestry* (IPCC GPG LULUCF, 2003).

***P 29 -** Project documentation shall include a description of land use trends and a discussion of their impacts to the project areas.*

***P 30 -** Project documentation shall include a common practice analysis that describes how the renewal of forest cover in the absence of carbon finance is not a likely land uses scenario, that the implementation of project activities are outside of the business as usual practices, and that the renewal of forest cover is only possible through the creation and sale of carbon offsets generated by the project.*

3.4.1 Afforestation Baseline Scenario

In the case of most Afforestation projects, the baseline scenario will be that the land will remain in its current use. The scope of this Protocol effectively limits the range of potential baseline scenarios to ensure they are additional. Given the length of time that the land has been non-forested and under another land use, such as agriculture, based on the findings of P29 and P30 it shall always be determined that it is reasonable to assume that the land would not become forested without the project. Therefore, the reasonable baseline scenarios range from no management activity to agricultural activity ranging from grazing to intensive cultivation. Vegetation present at the start date of the project may include Grass, sedge shrubs and some trees and shrubs.

***P 31 -** Afforestation project documentation shall include a description of how the baseline scenario meets the description provided above and the eligibility criteria described in section 3.2 above.*

***P 32 -** Project Documentation shall include an assessment of the vegetation that would likely develop in the absence of the project.*

Three approaches to assessing carbon flux in the baseline scenario may be applicable. (Continuation of Current Use, Comparison-based and Projection- based) in the baseline scenario are accepted under this Protocol. The Criteria are fully described in Table 1 below.

P 33 - Afforestation project documentation shall include the rationalisation for the selection of one of the following three baseline quantification methods using the criteria described in Table 1

Afforestation - Continuation of Current Use Approach

The selection of this method would apply to Afforestation projects where the land is currently in a relative steady-state of activity and the amount of carbon in key pools is stable. In the absence of the Afforestation project, the current land use would continue and within the project site there would be no change in the current level of the carbon reservoirs and no increase or decrease in sources or sinks, except that associated with the continued development of existing advance tree regeneration and potential ingress. The project site has been non-forest for at least 20 years prior to project initiation. While there may be some pre-existing trees present, especially if the area is abandoned agricultural land, the site is not expected to naturally convert to forest. There are no plans, directives, regulations or programs that require the site to be afforested. Such conditions may be found on agricultural land that has not been intensively managed for a significant length of time (e.g. 20 years or longer), or where the land management practice has been unchanged for an equally long period of time. In general, given the economic conditions of the agriculture and forest sectors (including land value, commodity markets and tax structures) it is reasonable to assume that the pre-project activities will continue for at least the length of the project term. The criteria for the selection of this approach is described in table 1.

Afforestation - Projection-based Approach

This baseline type would be applicable to Afforestation projects where a change in some aspect of the current management of the land is forecast, while the site remains eligible for an offset project. Such conditions may be found on agricultural land that is abandoned or which has been extensively managed, and which is expected to experience an increase in management intensity in future. The basis for the projected change could be land use trends in the vicinity of the project, anticipated changes in zoning, or other information available to the project developer. The PDD shall justify the projected timing of the land management transition, the new management approach, and apply a generally accepted estimate of the carbon impacts associated with the transition and the new land management approach. For example, if abandoned farmland was to be converted to hay production, the emissions associated with conversion and the carbon storage as hayfield would all be incorporated into the development of the baseline. Such a baseline is appropriate for use where projects are undertaken in regions that are experiencing a significant rate of agricultural management intensification. The criteria for the selection of this approach is described in Table 1.

Afforestation - Comparison-based Approach

This baseline type would be applicable where a representative control site can be established at the same time as the project. For example, if a proponent afforests a portion of an agricultural area, the remaining area may be used to represent the baseline and monitored accordingly. Alternatively, a proponent may use neighbouring farmland for the same purpose if conditions are comparable. This approach is readily verifiable and adds considerable transparency and consistency to the basic scenario approach, although monitoring and verification costs will likely be higher than under other baseline approaches.

The main drawback is that there may not be comparable sites where a strong argument can be made that the site would have followed the same development pathway. A proponent may choose to establish and monitor control plots as a baseline or to improve confidence and accuracy in the project baseline. If this approach is being used, the location of the control plots must be recorded and justified (i.e. demonstrate that the control plots are representative of the project site baseline conditions). Measurement and monitoring procedures for control sites should be the same as those used in the project site, the criteria for the selection of this approach are described in Table 1.

3.4.2 Reforestation Baseline Scenario

In the case of reforestation projects, project areas may at the start date have live trees present or some potential for some natural renewal, but there is not enough renewal to produce a forest (or potential forest) within 10 years. However, these trees must be accounted for so they do not contribute to the assessed project benefits. While there may be some increase in existing tree biomass, or ingress of new trees during the next 10 years, the site will not return to forest within at least 10 years. In the case of reforestation projects on land that is being managed for a purpose other than forestry, or which is being rehabilitated, there are unlikely to be any existing trees and the project will essentially be the same as an Afforestation project except that the land has not been without forest for long enough to meet the requirements of an Afforestation project. There will either be no change or a small, gradual increase in the current level of the living biomass reservoirs (i.e. there may be some live trees on site) and either no increase or a small, gradual increase in sinks. There are no plans, legal requirements or programs that require the site to be re-forested. (As described in section 3.2 Eligibility)

> ***P 34 -** Reforestation project documentation shall include a description of how the baseline scenario meets the description provided above and the eligibility criteria described in Section 3.2 above.*
>
> ***P 35 -** Project Documentation shall include an assessment of the vegetation that would likely develop in the absence of the project.*

Three methods for forecasting carbon flux in the baseline scenario of reforestation projects may be applicable. (Continuation of Current Use, Comparison-based and Projection- based as described in table 1 below)

***P 36 -** Reforestation project documentation shall include the rationalisation for the selection of one of the following three baseline quantification methods using the criteria described in Table 1*

Reforestation - Continuation of Current Use Approach

The selection of this method would apply to reforestation projects where the land is currently in a relative steady-state of activity and the amount of carbon in key pools is stable. In the absence of the Reforestation project, the current land use would continue and within the project site there would be no change in the current level of the carbon reservoirs and no increase or decrease in sources or sinks, except that associated with the continued development of existing advanced tree regeneration and ingress. There are no plans, directives, regulations or programs that require the site to be reforested. In general, given the economic conditions of the forest sectors (including land value, commodity markets and tax structures) it is reasonable to assume that the pre-project activities will continue for at least the length of the project term. The criteria for the selection of this approach is described in Table 1.

Reforestation - Projection-based Approach

This baseline type would be applicable to reforestation projects where a change in some aspect of the current management of the land is forecast, while the site remains eligible for an offset project. The basis for the projected change could be land use trends in the vicinity of the project, anticipated changes in zoning, or other information available. The PDD shall justify the projected timing of the land management transition, the new management approach, and apply a generally accepted estimate of the carbon impacts associated with the transition and the new land management approach.

The criteria for the selection of this approach are described in Table 1.

Reforestation - Comparison-based Approach

This baseline type would be applicable where a representative control site can be established at the same time as the project. This approach is readily verifiable and adds considerable transparency and consistency to the approach, although monitoring and verification costs will likely be higher than under other baseline approaches. The main drawback is that there may not be comparable sites where a strong argument can be made that the site would have followed the same development pathway. A proponent may choose to establish and monitor control plots as a baseline or to improve confidence and accuracy in the project baseline. If this approach is being used, the location of the control plots must be recorded and justified (i.e. demonstrate that the control plots are representative of the project site baseline conditions). Measurement and monitoring procedures for control sites should be the same as those used in the project site. The criteria for the selection of this approach are described in Table 1.

3.4.3 Static and Dynamic Scenarios

The continuation of current and projection approach for this Protocol is static. The emissions profile for the baseline activities does not change during the registration period. In contrast, the comparison-based baseline scenario is dynamic, since the comparison is against a reference site on which processes will continue to operate through time. However, it is expected that the rate of change in the SSR will be negligible, since the land use of the reference site is not expected to change over time.

Table 1 - Possible AR Baseline Quantification Methods for Estimating GHG Removals

Baseline Option	Afforestation	Reforestation
Continuation of Current Use		
• Description	Continuation of current land management activities and related changes in C reservoirs due to changes in existing vegetation and potential ingress.	Continuation of current land management activities and related changes in C reservoirs due to changes in existing vegetation and potential ingress.
• Static or Dynamic	Static	Static
• Accept or Reject and Justify	Accept when land use trends suggest low rates of land use change which prevail where agricultural land may be used for Afforestation projects.	Accept when land use trends suggest low rates of land use change where land may be found that is eligible for reforestation projects.
Comparison-based		
• Description	Establishment and monitoring of control group.	Establishment and monitoring of control group.
• Static or Dynamic	Dynamic	Dynamic
• Accept or Reject and Justify	Accept if strong evidence can be provided regarding the validity of the control group. Discussed above.	Accept in the case of reforestation of post-disturbance sites.
Projection-based		
• Description	Projection of expected land management activities and related changes in C reservoirs.	Projection of expected land management activities and related changes in C reservoirs.
• Static or Dynamic	Static	Static
• Accept or Reject and Justify	Accept when a limited range of likely activities and biomass growth on applicable land types present. Allows use of existing ecosystem C modelling results. Discussed further below.	Accept when a limited range of likely activities and biomass growth on applicable land types present. Allows use of existing ecosystem C modelling results. Discussed further below.
Direct Measurement		
• Description	Measurement of all emissions and sequestration associated with all	Measurement of all emissions and sequestration associated with all

	direct project activities; emissions associated with indirect effects could be estimated.	direct project activities; emissions associated with indirect effects could be estimated.
• Static or Dynamic	Static	Static
• Accept or Reject and Justify	Reject when high costs of measurement and high degree of technical difficulty is prohibitive unless it can be justified on a case-by-case basis.	Reject when high costs of measurement and high degree of technical difficulty is prohibitive unless it can be justified on a case-by-case basis.

3.5 Identification of Sources Sinks and Reservoirs (SSR)

Sources Sinks or Reservoirs (SSR) are pools of carbon that can be measured or estimated and are defined as followed.

Source: Physical unit that releases a GHG into the atmosphere,

Sink: physical unit or process that removes a GHG from the atmosphere

Reservoir: Physical Unit or component of the biosphere or hydrosphere with the capability to store or accumulate a GHG removed from the atmosphere in a GHG sink or captured from a GHG source.

3.5.1 Affected, Related or Controlled SSRs

The identification of SSR is important for maintaining consistency in the representation of the flux of carbon from one pool to another. This Protocol identifies SSRs that are controlled by, related to or affected by an Afforestation/reforestation project.

SSRs that are controlled by the project proponent are based on the flux of carbon from at atmosphere to plants (Biomass). These include all above and belowground biomass accumulation and soil organic carbon.

They are either located in the project area or are due to the proponent's operations undertaken to implement the project. In the case of Afforestation and reforestation projects these will be: the planted seedlings or trees (above-ground and below-ground biomass) and the fossil fuel emissions from machinery used in establishment and maintenance.

SSRs that are related to the project are based on the impacts of the project implementation

They have material or energy flows into, out of, or within the project. A related GHG source, sink or reservoir is generally upstream or downstream from the project, and is usually off the project site. SSRs that are related to an Afforestation or reforestation project include harvested wood products (HWP) and the CO_2 and other GHG emissions from the use of fertilizers and fossil fuel to establish and maintain the plantation.

SSRs that are affected are those which are influenced by the project implementation

They are influenced by the project activity through changes in market demand or supply for products or services associated with the project. For example, an increase in wood supply and production due to a project may apply downward pressure on timber prices and reduce local harvest levels, or lead to a change in land use (i.e. deforestation). If present, leakage is an affected SSR; in general, projects considered under this stand will be too small to have material impacts on affected SSRs

__P 37 -__ Project Documentation shall identify all controlled, related and affected, SSRs and all Upstream, On site and Downstream SSRs as described by the conditions set out in Table 2.

__P 38 -__ For individual project SSRs that amount to less than 2% gross GHG removal will be considered de minimis.

***P 39** - For aggregate project SSRs that amount to less than 5% gross GHG removals will be considered de minimis*

A de minimis SSR need not be quantified on the grounds that omitting it will not influence the number of Carbon offset Credits calculated for a project. Table 2 outlines the criteria for identifying SSRs that are controlled affected or related.

Table 2 - Description of SSRs controlled Related or Affected by Baseline and Project Scenarios

SSR	Description - Project	Description - Baseline	Controlled, Related or Affected SSR
Upstream SSR			
1. Fossil fuel combustion	Fossil fuel used (for heat or electricity production) in seedling production and for transport of planting stock, labour and equipment to project site	Fossil fuel used (for heat or electricity production) to power barns for livestock mgmt during winter	R: Project leads to higher tree seedling production
2. Emissions from fertilizer use	Non-CO_2 GHG emissions (CH3 and N2O) from fertilizer used in seedling production	N/A	R: Project leads to higher tree seedling production

3. Fertilizer production	Emissions generated in the production of the fertilizer used on the project site	Emissions generated in the production of the fertilizer used on the project site	R: Fertilizer can be produced by a number of processes, all of which require energy inputs such as natural gas and electricity. Quantities and types of energy use can be tracked to evaluate functional equivalence with the baseline
Onsite SSR			
4. Above-ground live C reservoir	Biomass in live trees, including branches and foliage	Biomass in crops or in any live trees on site	C: Above-ground biomass of trees increases over time with growth; crops, pasturage or other non-tree vegetation is managed under the baseline scenario
5. Below-ground live C reservoir	Live tree root biomass	Live root biomass of crops and any trees on site	C: Below-ground biomass of on-site trees increases over time with growth; little change expected over time in this pool under continued agricultural use
6. Above ground dead wood & litter C reservoir	Biomass in standing and lying dead wood and litter	Biomass in standing and lying dead wood and litter on site.	C: Biomass in dead wood and forest litter increases over time as plantation develops; difference from baseline depends on pre-project site characteristics.
7. Soil organic C reservoir	Organic C, dead root and live fine root content of soil	Organic C, dead root and fine live root content of soil	C: Organic C in soil may increase or decrease over time as plantation develops, depending on factors such as past use, soil properties and climate regime; may change slightly under baseline
1b. Fossil fuel combustion	In vehicles used for site preparation, plantation maintenance, monitoring and any harvesting activities	In vehicles used for the cropping and management of land	C: Transportation requirements associated with implementing project, including establishment and tending, may lead to higher CO_2 emissions unless the site was actively managed in its previous use

8. GHG emissions — fertilizer	CO_2 and N_2O emissions resulting from application of fertilizer	CO_2 and N_2O emissions resulting from application of fertilizer	C: If fertilizer is applied to the site, there will be GHG emissions
Downstream SSR			
1c. Fossil fuel combustion — transport of harvested biomass	Transport of any harvested biomass to processing facility	Transport of harvested crops, livestock to market	R: Transportation of harvested biomass to mill or other facility will lead to higher CO_2 emissions, although there could be a substitution effect here.
9. Processing facility	Process emissions at wood product or biomass energy facility	Emissions related to energy used in processing of crops /food products	R: Processing of harvested crops or timber biomass at mill or other facility will lead to higher CO_2 emissions
10: Harvested wood products	Wood from thinning or partial harvests may be converted into wood products. A proportion of the products remains for some time in the products pool and can be considered as offsets	Some reforestation project baselines may include timber harvesting for the purposes of producing wood products	R: HWP act as reservoir during their lifetime and after land filled, depending on their fate.
11. Baseline activity shifting (leakage)	Emissions associated with relocation of baseline activity to a new site	N/A since default baseline is that current land use will continue indefinitely	R: Activities associated with any shift in the location of the baseline activity may lead to higher CO_2 emissions
12. Forest management (FM) activities	Market-related changes in FM activities	N/A for Afforestation projects since the land is not forested; N/A/ for reforestation projects due to continuing land use assumption	A: The project may substitute for, reduce or increase regional level of FM activities.
13. Afforestation/ reforestation (A/R)	Market-related changes in A/R rates	N/A due to continuing land use assumption.	A: The project may substitute for, reduce or increase regional level of Afforestation or reforestation
14. Deforestation	Market-related changes in	N/A due to continuing	A: The project may substitute for, reduce or increase regional

	deforestation rates	land use assumption.	level of deforestation.
15. Regional harvest rates	Market impact of increased supply of wood from project	N/A due to continuing land use assumption.	A: The project may influence regional harvesting levels.

3.5.2 Description of Reservoirs

Carbon stocks from biomass in AR projects are stored in the following six broad classes of reservoirs, or pools, all of which may be affected by Afforestation and Reforestation project activities[7] and will be accounted for in eligible projects:

Above-ground live biomass

Above-ground biomass includes all live vegetative biomass above the soil including stem, stump, branches, bark, seeds and foliage. The biomass contained in the trees is the primary source of carbon stocks will be quantified in tC and reported in tCO_2e. For the projects considered under this Protocol, there may be shrub and herbaceous material present on site. This may be in the form of an understory in a reforestation project, or the shrubs may be the tallest vegetation present prior to project initiation.

Below-ground biomass

Below-ground biomass refers to the biomass in the live tree roots. Fine roots of less than 2 mm diameter, which usually include most of the roots of the shrubs and herbaceous material, are often included as soil carbon or litter because it is difficult to distinguish them empirically from soil organic matter or litter. A root: shoot ratio, based on values used in Canada's National GHG Inventory system or obtained from other reputable sources, is used in this Protocol.

Dead Wood and Litter (or Dead Organic Matter)

This pool consists of above ground dead wood and forest litter. There are two components to dead wood – standing dead wood and lying dead wood. Both classes of dead wood are subject to the same dimensions – a minimum DBH of 10 cm in the case of standing dead wood, and a minimum average diameter of 10 cm for lying dead wood. Lying dead wood is at least 2.4 metres long. Dead woody material that is too small to be considered lying dead wood is classed as litter, which includes branches, stumps, leaves and duff. The distinction is important since dead wood should be sampled, whereas the quantification of forest litter can be based on values obtained from scientific literature. For Afforestation project, many sites will have no existing tree cover, and pre-project levels of litter and dead wood is often will be negligible. Choosing to omit the estimation of the carbon stored in dead

7 Reference: Draft 2006 IPCC Guidelines

wood and litter built up during the life of the project adds to the conservatism of the estimate of project impacts.

In contrast, a reforestation project could have a considerable amount of dead woody material present, as well as a litter layer. The dead material may be caused by the natural disturbance, or it may be debris left after salvage harvesting. However, the relative rates of creation of dead woody debris in the baseline and the project will be compared. In both types of project, the litter layer that develops during the project will at least partially offset the loss of the biomass in the litter layer present on the site prior to the project.

Soil Organic Carbon

Soil organic carbon includes organic carbon in mineral soils, dead roots and live fine roots that cannot be empirically distinguished from the soil. Project impacts, especially from Afforestation projects, will usually be relatively low and positive (i.e. a gradual increase in soil carbon storage over time) and so, given the expense associated with assessing soil carbon content, Tree Canada may ignore soil carbon changes in all cases. Tree Canada may undertake to measure soil carbon to improve the accuracy of the estimate of GHG reductions and removals; however there is no requirement to measure soil carbon.

In the absence of practices such as conservation tillage, agricultural lands, particularly those that are candidates for conversion to forests, generally do not accumulate significant amounts of carbon. Therefore, in the absence of information to the contrary, a baseline assumption that the area would have remained as agricultural land implies that there is no significant change in carbon stock over time other than natural succession and ingress. It is highly unlikely that land which falls within the scope of this Protocol would show a significant positive trend in carbon stocks (a sink) under the baseline scenario, although there is some potential minor increase in carbon stocks if there are young trees which have become naturally established on the project site.

Harvested Wood Products

If and when the trees planted in the project are harvested and removed from the site to be processed into Long lived (100 years [8]) forest products (includes softwood lumber, hardwood lumber, and panel products OSB, plywood and non-structural panels) and a portion of the carbon stored is assumed to be retained as offsets. The balance of these products will be considered to be short-lived, and will be emitted at the time of harvest. The carbon stocks associated with the rest of the harvested trees, including that stored in the roots, is assumed to be emitted at the time of harvest.

Projects may also include pre-commercial and commercial thinning operations, which will lead to the generation of emissions that must be accounted for, including downstream emissions associated with the removal of wood from the project site, and its subsequent processing and disposal. One of the

[8] James E. Smith, Linda S. Heath, Kenneth E. Skog, and Richard A. Birdsey, General Technical Report NE-343 Methods for Calculating Forest Ecosystem and Harvested Carbon with Standard Estimates for Forest Types of the United States, USDA Forest Service, April 2006. Available at http://www.fs.fed.us/ne/durham/4104/papers/ne_gtr343.pdf

challenges with commercial thinning is to estimate how the thinned biomass will be used, since this influences the emissions associated with them. If the thinnings are used to manufacture long-lived forest products, some of the carbon will be stored in the product for a sufficient length of time for it to be considered permanently removed, and so contribute to the quantity of offsets generated. While biomass used to produce energy was formerly considered not to create emissions, under international accounting rules, the balance of evidence has shifted so that the extent of emissions must be assessed on a case by case basis.

The amount of carbon removed as harvested biomass from the project site (and therefore emitted) should be determined through regular monitoring and reporting procedures set out by the project proponent (See Section 3.9). The carbon in all used products is all assumed to be emitted, in part because landfill managers are seeing changes in the composition of waste streams as well as increased capture of off-gases, which creates substantial variation in decay rates across different landfill locations and over time. Omitting the inclusion of carbon stored in landfills is conservative. This will mean a small reduction in the quantity of offsets created in the project.

3.5.3 Comparison of Project and Baseline SSRs

In order to remain consistent in the accounting of carbon stocks for the baseline and project scenario proponent should explain how the project and the baseline scenarios are comparable in terms of products and/or activity level, and justify any lack of equivalency. Table 3 allows for a ready comparison of the SSRs in both the project and the baseline scenario, and it can be seen that there is a high degree of overlap. SSR10 is the only baseline SSR that has no direct counterpart in the Project SSRs, whereas SSR2 and SSR11 – 15 have no direct counterparts in the baseline scenario.

> ***P 40*** *- Project documentation shall include an assessment of equivalency between the project and baseline scenario SSRs.*

3.6 Quantification of Project and Baseline SSRs

Table 3 in section 3.6.4 contains the elements required by this Protocol for inclusion in the quantification of Project and Baseline SSRs.

3.6.1 Requirements for assessing Carbon pools

Quantifying the GHG removals for the assertion of carbon offset credits for a typical Tree Canada Afforestation or reforestation project requires measurement or estimation of the carbon stocks in the major terrestrial carbon pools (Described in section 3.5.2 above) and the changes in these stocks over time. Reduction of emissions related to the land-use practices followed in the baseline scenario may contribute to the net GHG reductions resulting from the project. The quantification methodology prescribed in this Protocol limits the number of sinks, sources and reservoirs that must be measured and monitored. Exclusions are justified on the basis that either the SSR is not meaningful in the context of the project or the exclusion will result in a more conservative estimate of the project's net reductions and removals.

P 41 - *Project documentation shall include methods for the Sampling and estimation of carbon stocks over time as described in Section 3.7 and 3.9.*

3.6.2 Requirements for Assessing Fossil Fuels

Emissions associated with fossil fuel combustion for land management are generally required to be quantified under this Protocol. The measurement and monitoring of emissions directly related to a project's activities are not required if emissions from these sources are greater in the baseline scenario than with the project, would occur if the baseline was for the land to be cultivated.

P 42 - *Project documentation shall include information on the inclusion or exclusion of Fossil fuel combustion.*

3.6.3 Requirements for Assessing Fertilizers

Where fertilizer is used in the project, the emissions associated with it must be assessed. While these emissions will be of negligible importance in most projects, fertilizer production is a key global source of GHG emissions and so the use of fertilizer should be included in the analysis. Tree Canada may omit quantification of emissions from fertilization in the baseline scenario (if any); doing so only makes the project impacts more conservative. However, Tree Canada may wish to include it if fertilization is part of the project in order to balance the project impact.

P 43 - *Project documentation shall include information on the inclusion or exclusion of fertilizer application.*

3.6.4 Criteria for the Inclusion of Project SSRs

The following table 3 outlines the requirements for the inclusion or exclusion of identified SSRs towards the net GHG removal.

P 44 - *Project Documentation shall include a justification for the inclusion or exclusion of project SSRs as per table 3 of this Protocol. Proponents shall provide evidence and rationalisation to support any change to the inclusion or exclusion of SSR.*

Table 3 - Inclusion and Exclusion of Project SSRs

Identified SSR	Baseline (C,R,A)	Project (C,R,A)	Include or Exclude from Quantification	Justification for Exclusion
Upstream SSR during Operation				
1a. Fossil fuel combustion — seedling production	N/A	R	Exclude	The emissions from fossil fuel that is combusted to heat the greenhouses where the seedlings are produced is not considered to be significant.
1b. Fossil fuel combustion — agriculture in the case of Afforestation; forest operations in the case of reforestation	R	N/A	Exclude	This SSR may not be relevant if the project site was unmanaged; if it was actively managed, exclusion likely results in a more conservative estimate of project's net GHG R/R
1c. Fossil fuel combustion — labour and materials transport	N/A	R	Exclude	The emissions from fossil fuel that is combusted to transport labour and materials to the project site is not considered to be significant.
2. Emissions from fertilizer use — seedling production	N/A	R	Exclude	The emissions from fertilizer used to produce the tree seedlings is not considered to be significant.
3. Fertilizer production	A	A	Exclude	The emissions associated with an increase in the quantity of fertilizer production due to the project will be insignificant, even if a project includes fertilizer use.
Onsite SSR during Operation				
4. Above-ground C reservoir	C	C	Include: live trees and shrubs	Live tree, above-ground biomass must be considered in the baseline, as well as the project. Live aboveground shrub biomass must also be included where the shrubs have a diameter of at least 2 cm at a stem height of 10 cm. The amount of live herbaceous biomass is not considered significant and the baseline amount will be offset to some extent by the herbaceous layer in the project.

5. Below-ground C reservoir	C	C	Include: live trees only	Live tree, below-ground biomass must be considered in the baseline, as well as the project. Shrub and herbaceous live below-ground biomass is not large enough to be distinguished from general soil organic matter and so is considered to be not significant
6. Standing Dead Wood	C	C	Include	Dead wood must be quantified at the project start, and forecast in both the baseline and the project.
7. Lying Dead Wood	C	C	Include	Dead wood must be quantified at the project start, and forecast in both the baseline and the project.
8. Litter C reservoir	C	C	Exclude	Project is likely to increase the amount of litter and omission of litter that accrues due to a project results in more conservative estimate of project's net GHG R/R.
9. Soil Organic C reservoir	C	C	Exclude	Project impacts are likely to be positive over the project period. Any changes will not be significant and exclusion results in more conservative estimate of project's net GHG R/R.
1c. Fossil fuel combustion — plantation/on- site operations	C	C	Include	Not significant and exclusion results in more conservative estimate of project's net GHG R/R
10. Non- CO_2 GHG emissions — prescribed burning	N/A	C	Exclude	Exclusion of any burning done in conjunction with the baseline results in a more conservative estimate of the project's net GHG R/R. Projects that include prescribed burning for site preparation are ineligible under this standard.
11. Non- CO_2 GHG emissions — fertilizer	C	C	Include if fertilizer applied in project; otherwise optional	Fertilization in a project accounts for emissions that can be assessed using default factors. Tree Canada can omit consideration of fertilizer use in baseline if it is not present in the project.

Downstream SSR during Operation				
1d. Fossil fuel combustion – transportation of product to processing facility	R	R	Exclude	Emissions from combusting fossil fuel to transport harvested wood /agricultural products to a processing facility are judged to be not significant since the amount of harvesting permitted in a project is limited. If the baseline land use creates agricultural products, the baseline emission can be expected to outweigh those in the project.
10. Crop/food processing facility	R	R	Exclude	Exclude, for reasons analogous to those for excluding emissions associated with transport of product to mill.
11. Market impacts — agri-foods	A	N/A	Exclude	Exclude, since the scale of Tree Canada projects is very small relative to the regional landbase and supply capacity.
12. Harvested wood products	R	N/A	Exclude	Exclude, since the scale of Tree Canada projects is very small relative to the regional landbase and supply capacity.
13. Baseline activity shifting	N/A	R	Exclude	Baseline activity shifting (Leakage) should not be assumed to be zero. However, since Tree Canada project are undertaken on areas which meet the additionally criteria it is unlikely that any leakage impacts be measurable and significant through the project life. Furthermore, since the scale of Tree Canada projects (at this time) is very small relative to the regional landbase and supply capacity it is unlikely to have any effects.
14. Forest management (FM) activities	N/A	A	Exclude	Exclude, since the scale of Tree Canada projects is very small relative to the regional landbase and supply capacity.
15. Afforestation/ reforestation (A/R)	N/A	A	Exclude	Exclude, since the scale of Tree Canada projects is very small relative to the regional landbase and supply capacity.
16. Deforestation	N/A	A	Exclude	Exclude, since the scale of Tree Canada projects is very small relative to the

				regional landbase and supply capacity.
17. Regional harvest rates	N/A	A	Exclude	Exclude, since the scale of Tree Canada projects is very small relative to the regional landbase and supply capacity.

3.7 Quantification of Net GHG Emission Removals

3.7.1 Equations Used

This Protocol uses a “Stock Change” method for quantifying the increase in Carbon stocks from the project relative to the baseline carbon stocks for a given period. The difference between the baseline Carbon and the project Carbon Stocks is the GHG removal for the period.

The equations for quantifying the total emissions from the SSRs included in the Afforestation or reforestation project and the associated baseline scenario, are provided below (Project SSRs are identified with a “P” in front of the SSR number from Table 3 above.):

Equation 1- Net Project GHG removal

$$\sum \text{Emissions from Project} = - P4 - P5 - P6 - P7 + P11 + P1c$$

The biomass in the Above-ground live biomass (SSR P4), Below-ground live biomass (SSR P5), Standing dead wood (SSR P6), and Lying dead wood (SSR P7) are all expected to increase as biomass increases.

Because the equation calculates the emissions from the project, the negative values of the sequestered CO_2-equivalent are used in Equation 1. Emissions associated with fertilization and on-site fossil fuel emissions will detract from the net project benefit, although the fertilization emissions may be more than offset by increased survival and/or growth rates. Baseline SSRs are identified with a “B” in front of the SSR number.

Equation 2 - Net Baseline GHG Removals

$$\sum \text{Emissions from Baseline} = - B4 - B5 - B6 - B7 + B11 + B1c$$

Equation 2 includes all potential sources in a baseline scenario, which would typically be required for a reforestation project where there was a significant amount of standing and lying dead wood from the previous stand, and where site preparation and fertilization is undertaken. However, in the most typical Afforestation baseline scenario, where the project land does not have any woody vegetation present, or that vegetation is sparse and is not removed during project establishment, the Above-ground and Below- ground biomass live and dead biomass reservoirs will not be material and can be excluded. Fertilization and emissions from fossil fuel use would only be relevant if the project site was cultivated land. Furthermore, soil carbon is expected to be stable. Any burning that may be done in the baseline, such as stubble burning, will release minor amounts of CO_2 and ignoring such emissions only makes the project calculations more conservative.

Where there is some live woody vegetation in the project site that is removed during project establishment, such as when an old field is being afforested or the reforestation site has live trees remaining from the previous stand, the sum of net emissions under the baseline scenario is quantified according to Equation 3:

Equation 3 – Net Baseline Emissions

∑Net Emissions of Existing Woody Veg. Baseline = - B4 - B5 – B6 – B7

In Equation 3, the values of B4 and B5 represent the mature volume that the existing woody vegetation would attain during the time frame of the project. Its removal and replacement with new project trees must be counted against the amount of carbon that will be sequestered by the project. The amount of dead woody debris present at the end of the project time frame also enters into the baseline scenario to be counted against the carbon sequestered by the project. Depending on the project length and the baseline management approach, any dead woody debris that might be present at the start of a project may have completely decayed naturally during the baseline scenario, in which case there is no impact on the offsets generated by the project.

The quantification of the above-ground live tree and shrub biomass reservoir represents the above-ground C content of the biomass per hectare, multiplied by the number of project hectares and then multiplied by the factor for deriving the amount of CO_2 equivalent from the number of kg of carbon in the above-ground biomass. For the live trees, the C content of their biomass is obtained by multiplying tree merchantable volume, by a Biomass expansion factor (BEF) that converts bole biomass to aboveground tree biomass, and then by a factor based on the weight of carbon per kilogram of biomass.

Once the merchantable volume of the trees in the project area has been determined, the biomass expansion factors presented in Appendix A are used to derive the total live tree CO_2stock. In Equation 4 below, the IPCC default value of 1.45 has been used as a Biomass Expansion Factor (BEF). Similarly, in Equation 5, the IPCC default root: shoot ratio of 0.40 was used

— **Appendix A** provides BEF values for key species in the regions of Canada. If a suitable biomass equation is available (instead of a merchantable volume equation), the calculated biomass can replace the contents of the square brackets in Equation 6 below.

Equation 4 – Total above ground Biomass

$$\text{ABG Biomass (t)} = [\text{MerchVol}(m^3) \times \text{Species Density } (t/m^3)] \times 1.45$$

Equation 5 – Total below ground biomass

$$\text{BLG Biomass (t)} = [\text{MerchVol}(m^3) \times \text{Species Density } (t/m^3)] \times 0.40$$

Equation 6 – Total Tree Carbon stock

$$\text{Total Tree Stock } (tCO_2) = [\text{ABG(t)}+\text{BLG(t)}] \times 0.5\text{tC/tbiomass} \times 3.6667tCO_2/tC$$

Equation 7 – Total Harvested wood products Carbon Stock

$$\text{Long-lived HWP } (tCO_2) = [\text{HB(t)}*0.42 \times \exp(-0.017329 \times \text{PL})] \times 0.5\text{tC/tbiomass} \times 3.6667tCO_2/tC$$

Where:

ABG Biomass (ABG) = Above-ground live biomass in tonnes (t)

BLG Biomass (BLG) = Below-ground live biomass in tonnes (t)
Long lived HWP = HWP in use at project end in tonnes (t)
HB(t) Harvested biomass in tonnes (t)
PL = project length (years)
MerchVol = Merchantable volume of trees on project site in cubic metres (m^3)
Species Density = Wood density value from Appendix B, in t/m^3

Species-specific allometric equations can be used to derive an estimate of biomass from sampled estimates of merchantable volume (See Appendix A). In the absence of suitable allometric equations, and when measurement occurs prior to the trees achieving merchantable size, stem volume shall be calculated on the basis of a cone, using diameter measurements and estimates of tree height.

Biomass Expansion Factor: Regional BEF and root-shoot ratio (expressed as below-ground biomass-merchantable biomass) shown in Appendix A have been derived in Canada from parameters used in IPCC 2003 (Table 4). The below-ground BEF is used to estimate the carbon content of root biomass as direct Care must be taken if tree level equations are applied to stand level data, or vice versa. If stand level equations are used, tree level data must be converted to stand level data to be applicable.

Chen (2013) estimated that 42% of the timber harvested in Canada is used to make lumber and panel products, which have the potential to be in use at project end. The annual rate of loss of a stock of these products is 0.017329.

***P 45 –** Proponents may use BEF, Allometric equation or carbon accounting software to calculate the tonnes of Carbon stored within each respective pool in the baseline and project scenarios.*

3.7.2 Accounting for Deadwood

The standing and lying dead biomass that is present on a project site should be sampled in order to determine its abundant carbon stocks. Projects that involve salvage harvesting or site preparation will cause immediate emissions from this material, which would gradually decay if left undisturbed. Some portion would enter the litter layer and move into the soil carbon pool.

***P 46 -** Project with significant standing deadwood will refer to section 3.9 for the standard operating procedure for the sampling and quantification of this carbon pool.*

Table 4 - Parameters for Estimation of Above and Below Ground Carbon

SSR or Parameter	Factor
tCO_2e / t Carbon	3.6667
Carbon (t) / Dry Biomass (t)	0.50
Density index (t/ m^3)	See Appendix B
Above-ground biomass (t) / merchantable biomass (t)	1.45
Root: Shoot ratio	0.40

3.7.3 Fertilisation

The application of nitrogen-based fertilizers will lead to increased N_2O emissions while urea-based fertilizers and liming will increase the emissions of CO_2. The calculation of the relevant GHG emissions associated with fertilization is essentially undertaken by measuring the amount of fertilizer applied, its nitrogen, ammonia or carbonate content and then applying appropriate factors to translate this into emission levels.

The relevant project specific data required to complete the calculation are readily available. The amount that is applied can easily be measured and the concentration of the relevant ingredient (e.g. nitrogen) is printed on the fertilizer package. The remaining parameters are available from IPCC/CDM publications (See Table 5 for factors related to N_2O emissions):

- Clean Development Mechanism (CDM). 2007. Estimation of direct nitrous oxide emission from nitrogen fertilization - Draft methodological tool CDM — A/R WG Fifteenth meeting Report Annex 06.
- Intergovernmental Panel on Climate Change (IPCC). 2006. N_2O Emissions from Managed Soils, and CO_2 Emissions from Lime and Urea Application. Chapter 11: of 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Edited by Simon Eggleston, Leandro Buendia, Kyoko Miwa, Todd Ngara, and Kiyoto Tanaba.

Table 5 - Parameters for Calculating SSR Carbon Stocks

Project /Baseline SSR	Parameter / Variable	Unit	Measured/ Estimated	Method	Frequency	Justify measurement or estimation and frequency
4. Above-ground live tree and shrub C reservoir	C stock = above-ground live tree and shrub volume * biomass expansion factor(s) * project area * C- CO_2 conversion					
	C stock	tCO_2	Estimated (Measurement would result in destruction of project)	Calculation	Project start and monitored based on registry or contractual requirements	Frequency limit specified in OS rules
	above-ground live tree and shrub volume	m^3/ ha		Field measurements; statistical sampling		
	Biomass Expansion Factor	tC/ m^3	Estimated	Species-specific factors	Review at re-registration	C content of trees can vary significantly between samples. Using factors based on larger samples should be more accurate.
	project area	ha	Estimated or measured	Field survey and/or map-based	Total project area must be fixed at registration	Project performance must always be based on total area.
	C-CO_2 conversion	tCO_2/tC	Estimated	Factor (44/12) from published IPCC Guidelines	Review at re-registration	Factor is not likely to change.
5. Below-	C stock = root-shoot ratio * above-ground live tree and shrub volume * biomass expansion factor(s) * project area * C-CO_2 conversion					

ground live tree and shrub C reservoir	root-shoot ratio	no units	Estimated	Species-specific factors	Review at re-registration	Destructive sampling would be required to measure this reservoir.
6. Standing dead wood C reservoir	C stock = estimate of original live biomass * tree loss adjustment * density loss adjustment * project area * C- CO_2					
	C stock	tCO_2	Estimated			
	Original above-ground	m^3/ ha	Estimated and /or	Field measurements;	Project start and monitored	Frequency limit specified in OS
	Biomass loss factor by tree	No units	Estimated	Field assessment	As above	As above
	Biomass loss for entire tree	No units	Calculated	Product of data in Table 6 multiplied	As above	As above
	Decay class	No units	Estimated	Field assessment	As above	As above
	Density adjustment due to decay	No units	Calculated	Product of data in Table 6 multiplied by assessed loss	As above	As above
7. Lying dead wood C reservoir	C stock = estimate of log volume * density loss adjustment * project area * C-CO_2					
	C stock	tCO_2	Estimated			
	Log volume	m^3/ ha	Estimated and /or measured	Field measurements; statistical	Project start and monitored based on registry or	Frequency limit specified in OS rules
	Decay class	No units	Estimated	Field assessment	As above	As above
	Density adjustment due to decay	No units	Calculated	Product of data in Table 11 multiplied by log	As above	As above
8. N_2O emissions from nitrogen fertilizer applied	N_2O emissions = [mass of fertilizer applied * N content * (1.0 — volatilization rate)] * emission factor * ratio of molecular weights * Global Warming Potential					
	mass of fertilizer applied	tonnes in given year t	Measured area	Measured as weight of fertilizer applied over project area	Determined each time fertilizer applied	Readily measured — key variable

	N content	g N/ 100 g fertilizer	Estimated	Calculated from N content on fertilizer	Determined each time fertilizer applied	Fertilizer content provides N concentration
	volatilization rate	Dimension- less	Estimated	Factor = 0.1 for synthetic fertilizer or 0.2 for organic fertilizer, from	Review at re-registration	Factor is not likely to change.
	emission factor	t-N_2O /t-N	Estimated	Factor =1% from published IPCC	Review at re-registration	Factor is not likely to change.
	ratio of molecular	t-N_2O /t-N	Estimated	Factor (44/28) from published	Review at re-registration	Factor is not likely to change.
	Global Warming Potential of N_2O	kg-CO_2e/ kg- N_2O	Estimated	Factor = 310 from published IPCC Guidelines	Review at re-registration	Factor is not likely to change.
9. Harvested wood products	C stock = volume of lumber and panels produced * % remaining in use * project area * C-CO_2					
	volume of lumber and panels produced	m^3/ ha	Estimated and /or measured	Estimated based on field measurements of OSB, sawlog and veneer log production and	Project start and monitored based on registry or contractual requirements	Frequency limit specified in OS rules
	% remaining in use	No unit	Derived from published research	Equation is exp(-k*t) Where t = length of time in use k = ln(2)/HL Half-life (HL) = 40 years	As above	As above

3.7.4 Assessment of Uncertainty

The following Table 6 is intended to describe the risk of improperly assessing the assumptions or measurements related to an SSR. In some circumstances it may be invalid or erroneous for a given project site; the assessment of risk in the table below is separate from the assessment of risk associated with reversals.

Table 6 - Identification of Uncertainty

Identified SSR	Significance of Reduction/Sequestration	Significance of Emission Growth	Risk Level	Key SSR
4. Above- ground C reservoir: Live trees and shrubs	Significant sequestration	Ignoring respiration, there will be no increase in emissions during the course of the project — harvest may occur prior to project producing significant amounts of dead wood.	Low — Biomass can be directly measured, and tree growth is relatively readily projected. Projecting shrub/ woody understory development is more challenging however the proportion of biomass in the understory is relatively low.	Yes
5. Below- ground C reservoir: Live tree roots	Significant sequestration	Ignoring respiration, there will be no increase in emissions during the course of the project.	Moderate — measurement is difficult and while there is a well-established body of science that supports root: shoot ratios, the values presented in the scientific literature are rarely age dependent, and are quite general in other respects.	Yes
6. Standing dead wood C reservoir	May be a meaningful reservoir	May be significant source if site preparation is undertaken in a reforestation project	Low - Moderate. Emissions from this reservoir may be significant in a reforestation project; development of dead wood is relatively difficult to predict.	May be important in some reforestation projects
7. Lying dead wood C reservoir	May be a meaningful reservoir	May be significant source if site preparation is undertaken in a reforestation project	Low - Moderate. Emissions from this reservoir may be significant in a reforestation project; development of dead wood is relatively difficult to predict.	May be important in some reforestation projects
8. Litter C reservoir	May be a meaningful reservoir	May be significant source if site preparation is undertaken in a reforestation project	Low. Quantity of carbon in this reservoir will be much less than in SSR 4.	May be important in some projects
1c. Fossil fuel	N/A	May be significant	Low. Consumption of fuel	May be

combustion — plantation/on- site operations		source in a project, especially when site preparation is undertaken.	can be measured directly and standard emissions factors applied.	important in some projects
11. Non- CO_2 GHG emissions — fertilizer	Fertilization may lead to increased growth and/or survival and may increase rates of sequestration	Minor emissions may result from fertilizer application in project	Low - fertilizer use in project can be measured and may be available or estimated for baseline	No

3.7.5 Description and Justification of Methods for Estimation of each SSR, Parameter or Sub-Parameter

The *IPCC Good Practices Guidance for Land Use, Land-Use Change, and Forestry (2003*) is the main reference for the methodologies specified in this Protocol. Further guidance from national, provincial and non- governmental expert sources on field measurement sampling procedures is identified by reference, below.

Estimates of above-ground and below-ground biomass will be based on statistical samples of field measurements. Table 5 and Table 7 summarize the monitoring procedures used to quantify the emission reductions and removals.

When calculating the verifiable GHG emissions/removals resulting from the project, field measurements are required for the above-ground biomass, including number of trees per hectare, diameter at breast height (DBH), and height. More detailed measurements may be taken if desired. While the effects of activities can often be estimated using standard tables and computer models, field measurements are preferred.

Field measurements (section 3.9) are converted to estimates of carbon stocks using models (expansion factors) that estimate above-ground biomass from the measured field variables. Below-ground biomass is then calculated as a simple ratio of above-ground biomass (root-shoot ratio). The amount of fertilizer applied can be determined as the weight of fertilizer applied, readily measured as number of bags x weight of each bag. The nitrogen content is provided and factors used to calculate the impact of N_2O emissions expressed in CO_2-equivalent units. Table 5 provides factors that should be used in the quantification of emissions, removals or reservoir stocks for each of the selected SSR, including non-biological sources.

Table 7 - Summary of Procedures for Measuring Carbon Stocks

Project / Baseline SSR	Parameter / Variable	Unit	Measured / Estimated	Method
4: Above-ground live C reservoir	above-ground tree and shrub volume	m^3/ha	Estimated based on measured indicators	Field measurements; statistical sampling
	biomass expansion factors: convert shrub and tree volume to above + below-ground biomass	tC/ m^3	Estimated	Calculation
	project area	Ha	Estimated	Field survey and/or map-based
5:Below-ground live C reservoir	root-shoot ratio	no units	Estimated	Calculation
6: Above-ground standing dead C reservoir	above-ground standing dead wood volume	m^3/ha	Estimated based on measured indicators	Field measurements; statistical sampling
	Volume reductions for breakage	%	Estimation factors applied based on field assessment	Field measurements; statistical sampling
	Wood density reductions for decay	%	Estimation factors applied based on field assessment	Field measurements; statistical sampling
7: Above-ground lying dead C reservoir	above-ground lying dead wood volume	m^3/ha	Estimated based on measured indicators	Field measurements; statistical sampling
	Wood density reductions for decay	%	Estimation factors applied based on field assessment	Field measurements; statistical sampling
8: N_2O emissions from nitrogen fertilizer application	mass of fertilizer applied	tonnes	Measured	Quantities applied are recorded
	N content	g N/ 100 g fertilizer	Calculated	Calculation
9: Harvested wood products	Estimated volume of potentially long-lived wood products	m^3/ha	Estimated based on measured harvest volume	Scaling in bush or weigh scale

	% manufactured HWP that survive to end of project period	%	Estimated	Derived from published data or available calculators

3.8 Quantification of Net Emission Reduction

The total reduction in emissions attributed to the project is the sum of the project net emissions subtracted from the sum of the baseline scenario net emissions. This is represented by Equation 8:

Equation 8 Net GHG Reduction

$$\sum \text{Emission Reductions} = \text{Total Baseline Emissions} - \text{Total Project Emissions}$$

Where the Total Baseline Emissions are calculated using either Equation 2 or Equation 3, depending on the circumstances of the site where the project is to be implemented, and Total Project Emissions are calculated according to Equation 1.

3.9 Standard Operating Procedures

3.9.1 Stratification

For some projects it will be beneficial to divide the project area into "strata" prior to measurement in order to improve the accuracy and precision of estimates. Stratification usually creates relatively homogenous units based on similarities in ground condition such as vegetation, topography or management history.

> ***P 47 -*** *All strata within the project area must be delineated on a map and the area measured from in the field or using Global Positioning System (GPS).*

The site characteristics of each stratum should be recorded, including site locator information and area in hectares. All major access routes and physical features of the overall site should be included on the project map. The project area can be measured directly using a wide range of devices, including chain, measurement of number of steps or paces, or the use of surveyors' instruments. At a minimum, if the project area is a right-angled quadrilateral, at least two adjacent sides must be measured. Alternately, the area can also be derived from a map or photographic image, where the scale is known.

3.9.2 Standing Dead Wood Volume

The basic overall approach is that the volume of the standing dead wood should first be estimated as if the full tree was present and alive, and then deductions can be made for missing parts and for the presence of decay.

The project proponent should determine the minimum dimensions of the material that is to be included in the sample. For example, the CCAR standard requires that all dead trees 12.5 cm DBH in size and larger must be inventoried, which includes assessing the species, the DBH, estimated (or modelled) live height, amount of the original tree that is actually present, and extent of decay. Note that deductions for cavities and broken tops may also be made for live trees.

Table 8 - Distribution of Biomass within a Tree

Tree Portion	Percent of Tree Biomass
Top 1/3	10%
Middle 1/3	25%
Bottom 1/3	65%

An ocular estimate is made of the portion remaining in each portion of the tree during field sampling. Deductions from gross volume are made for anything that reduces the tree's gross biomass, including breakage and cavities. The percentage remaining in each third is then summed to calculate the net biomass remaining in the tree. Tree density must then be adjusted to account for the varying states of decay in the remaining portion of the tree. Because standing dead wood does not have the same density as a live tree, a density reduction must be applied. Standing dead wood may fall into five decay classes, which must be recorded during the field sampling. The five decay classes, described in Table 8, are qualitative, based on the physical characteristics of the dead tree (USDA 2007, Woundenberg et al., 2010). The wood density of each species must be modified for decay classes 2 to 5 by multiplying the density by the relevant reduction factor, as displayed in Table 9.

Table 9 - Description of Decay Class Characteristics (standing dead wood)

Decay Class	Description of Condition of Standing Dead Wood
1	All limbs and branches are present, the top of the crown is still present, all bark remains, sapwood is intact with minimal decay, heartwood is sound and hard.
2	There are few limbs and no fine branches; the top may be broken; a variable amount of bark remains; sapwood is sloughing with advanced decay; heartwood is sound at base but beginning to decay in the outer part of the upper bole.
3	Only limb stubs exist; the top is broken; a variable amount of bark remains; sapwood is sloughing; heartwood has advanced decay in upper bole and is beginning at the base.
4	Few or no limb stubs remain; the top is broken; a variable amount of bark remains; sapwood is sloughing; heartwood has advanced decay at the base and is sloughing in the upper bole.
5	No evidence of branches remains; the top is broken; less than 20 percent of the bark remains; sapwood is gone; heartwood is sloughing throughout.

Table 10 - Wood Density Reduction Factors by Decay Class and Tree Type (standing dead wood)

Softwoods		Hardwoods	
Decay Class	Reduction Factor	Decay Class	Reduction Factor
2	1.0	2	0.80
3	0.92	3	0.54
4	0.55	4	0.43
5	0.29	5	0.22

3.9.3 Sampling

Measurements shall be undertaken in a manner that is statistically sound and verifiable — permanent sample plots in the project area are not required but may be established and monitored if desired. This Protocol allows for a combination of field measurement and the use of conversion or expansion factors, including the use of process models. This Protocol also provides some activity-based factors or coefficients that would reduce the need for on-site measurement.

Tree Canada may choose the most appropriate sampling approach for each particular project or individual stratum within a project. However, the sampling procedure must be auditable, repeatable and follow some basic statistical principles, achieving estimates at a precision level of within + 10% of the mean, with 95% confidence. The sampling procedure (or measurement plan) must also follow *IPCC GPG LULUCF* (2003, Section 4.3.3.4). Verifiable sampling procedures can be found in the following references:

- Government of Canada, 2004, Canada's National Forest Inventory

— Ground Sampling Guidelines:

https://nfi.nfis.org/documentation/index_e.shtml

- British Columbia Ministry of Forests, 2002, Stocking and free growing surveys procedures manual: http://www.for.gov.bc.ca/hfp/publications/00099/surveys/SurveysPr ocManual3.pdf

- Manitoba Conservation, Forestry Branch, 2001, Silviculture Surveys: http://www.gov.mb.ca/conservation/forestry/forest- renewal/pdfs/silvisurveys2.pdf

Situations where data cannot be collected through established means (as in Table 9) would affect the field measurements used to calculate above-ground C stocks. Remote sensing imagery could be used to determine if a significant reversal had likely occurred (e.g. due to fire or insect damage) but would not provide a sufficiently accurate estimate of above-ground C stocks for the calculation of a project's GHG removals during the period. However, if growth and yield equations that are applicable to the project site and species are available, these could be used to provide reasonable estimates until field data could be collected.

3.9.4 Monitoring

The minimum frequency of collection is specified by the Offset System rules for sinks projects (< 5 years since last issuance of Offset Credits). Annual verification is not necessary given the lasting evidence of the activities (i.e. the number and size of the trees).

3.9.5 Lying Dead Wood Decay Class

Lying dead wood consists of large long logs upon the forest floor. The CCAR standard stipulates that lying dead wood must have a minimum diameter of 12.5 cm and a minimum length of 2 m – anything smaller is classed as litter. Lying dead wood is unlikely to be present on Afforestation sites, however it may well be encountered on sites where a reforestation project is to be implemented. Lying dead wood is tracked for the same reasons that standing dead wood is – project activities, especially site preparation, may cause complete emissions of the carbon contained therein. Lying dead wood is sampled on the project site prior to project initiation, but after any salvage harvesting that might be intended for the site.

The manner for estimating the carbon content of lying dead wood is to sample the site to estimate volume by species, by decay class, and then to adjust the wood density for the amount of decay. The product of the adjusted density and the volume by species provides an estimate of the quantity of biomass present which can then be converted into a quantity of carbon. Field sampling should tally species, sufficient data to estimate log volume, and decay class. The decay classes are shown in Table 11:

Table 11 - Description of Decay Class Characteristics (lying dead wood)

Decay Class	Description of Condition of Lying Dead Wood
1	Sound, freshly fallen, intact logs with no rot; no conks present indicating a lack of decay; original color of wood; no invading roots; fine twigs attached with tight bark.
2	Sound log sapwood partly soft but cannot be pulled apart by hand; original color of wood; no invading roots; many fine twigs are gone and remaining fine twigs have peeling bark.
3	Heartwood is still sound with piece supporting its own weight; sapwood can be pulled apart by hand or is missing; wood color is reddish-brown or original color; roots may be invading sapwood; only branch stubs are remaining which cannot be pulled out of log.
4	Heartwood is rotten with piece unable to support own weight; rotten portions of piece are soft and/or blocky in appearance; a metal pin can be pushed into heartwood; wood color is reddish or light brown; invading roots may be found throughout the log; branch stubs can be pulled out.
5	There is no remaining structural integrity to the piece with a lack of circular shape as rot spreads out across ground; rotten texture is soft and can become powder when dry; wood color is red-brown to dark brown; invading roots are present throughout; branch stubs and pitch pockets have usually rotted down.

The wood density of each species must be modified for decay classes 2 to 5 by multiplying the density by the relevant reduction factor, as displayed in Table 12.

Table 12 - Wood Density Reduction Factors by Decay Class and Tree Type (lying dead wood)

Softwoods		Hardwoods	
Decay Class	Reduction Factor	Decay Class	Reduction Factor
2	0.87	2	0.74
3	0.70	3	0.51
4	0.40	4	0.29
5	0.29	5	0.22

The half-life is the number of years it takes for half of the initial inflow amount of wood product to be discarded. Research by Skog (2008) and Chen et al. (2013) indicates that in Canada the half-life of lumber and panels is close to 40 years. The equation shown in Table 5 allows the project proponent to calculate the amount of product still in use after t years, which would commonly represent the interval between the project harvest and the end of the project period. The carbon in wood used for pulp, paper, biofuel, and other shorter-lived uses is assumed to be emitted at the time of harvest.

At a national level, Chen et al (2013) estimated that 32% of harvested biomass was converted to lumber and 10% to structural and non-structural panels. These factors may be applied to material harvested from a project, or more locally specific conversion factors may be used.

3.10 Other Impacts

The project will not contribute any additional air pollutants. If the baseline scenario includes regular burning of the site, then the project will reduce the particulate and other pollutants associated with the baseline scenario. There is no readily available methodology for measuring this impact.

Conversely, forest plantations have the capacity to remove particulates from the atmosphere and to purify air. This would be a positive additional outcome of the project and could be measured using various leaf area indices, air quality data and relevant removal coefficients. However, the assessment and valuation of these benefits is difficult and controversial and they are best expressed qualitatively.

Forested areas generally have greater levels of biodiversity than agricultural fields or pasture land, especially if native, mixed tree species are planted in the project. Thus, another benefit of the project will be enhanced biological diversity. Finally, forested areas may have some positive impacts on the water table, and in regulating water flow and runoff, in comparison to agricultural lands. Although difficult to measure, these may also be benefits of Afforestation and reforestation projects.

4.0 Bibliography

Alberta Environment. 2009. Protocol for Afforestation projects (version 2). Specified Gas Emitters Regulation; Albertans & Climate Change.

British Columbia Ministry of Forests. 2002. Stocking and free growing surveys procedures manual.

Canadian Forest Service. 2008. Offset System Protocol for Afforestation Projects. Draft report, August 6, 2008. Available on request.

Chen, Jiaxin, S. Colombo, and M. T. Ter-Mikaelian. 2013. Carbon Stocks and Flows from Harvest to Disposal in Harvested Wood Products from Ontario and Canada. Climate Change Research Report CCRR-33. Ontario Ministry of Natural Resources.

Clean Development Mechanism (CDM). 2007. Estimation of direct nitrous oxide emission from nitrogen fertilization — Draft methodological tool CDM — A/R WG Fifteenth meeting Report Annex 06.

Dickmann, D.I., Isebrands, J.G., Eckenwalder, J.E., and Richardson, J. 2001. Poplar culture in North America. NRC Press, 397 pp.

Environment Canada. 1996. The State of Canada's Environment — 1996. Govern. of Canada, Ottawa, ON. Online at: http://www.ec.gc.ca/soer-ree/English/SOER/1996report/Doc/1-1.cfm?CFID=13927907&CFTOKEN=38837417

Environment Canada. 2008. Turning the Corner: Canada's Credit for Early Action Program. Final Program Guide. June 2008.

Government of Canada. 2004. Canada's National Forest Inventory — Ground Sampling Guidelines: https://nfi.nfis.org/documentation/index_e.shtml

Intergovernmental Panel on Climate Change (IPCC). 2003. Good Practice Guidance for Land Use, Land Use Change, and Forestry.

Intergovernmental Panel on Climate Change (IPCC). 2006. N_2O Emissions from Managed Soils, and CO_2 Emissions from Lime and Urea Application. Chapter 11: of 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Edited by Simon Eggleston, Leandro Buendia, Kyoko Miwa, Todd Ngara, and Kiyoto Tanaba.

ISO 14604-2:2006, Greenhouse gases — Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements.

Jenkins, J.C., Chojnacky, D.C., Heath, L.S., and Birdsey, R.A. 2004. Comprehensive database of diameter-based biomass regressions for North American tree species. USDA Forest Service Northeastern Research Station. General Technical Report NE-319.

Kull, S.J., Kurz, W.A., Rampley, G.J., Banfield, E.G., Schivatcheva, R.K. and M.J. Apps. 2006. Natural Resources Canada, Canadian Forest Service, March 17, 2005. Operational-Scale Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) Version 1.0: Draft User's Guide. Personal communication.

Manitoba Conservation, Forestry Branch. 2001. Silviculture Surveys.

Pearson, T., S. Walker, and S. Brown. 2005. Sourcebook for Land Use, Land- Use Change and Forestry Project. Winrock International.

Province of British Columbia. 2002. Managing your woodland: a non- forester's guide to small scale forestry in British Columbia.

Seely, B., Welham, C., and Kimmins, J.P. 2002. Carbon sequestration in a boreal forest ecosystem: results from the ecosystem simulation model, FORECAST. Forest Ecology and Management. 169: 123-135

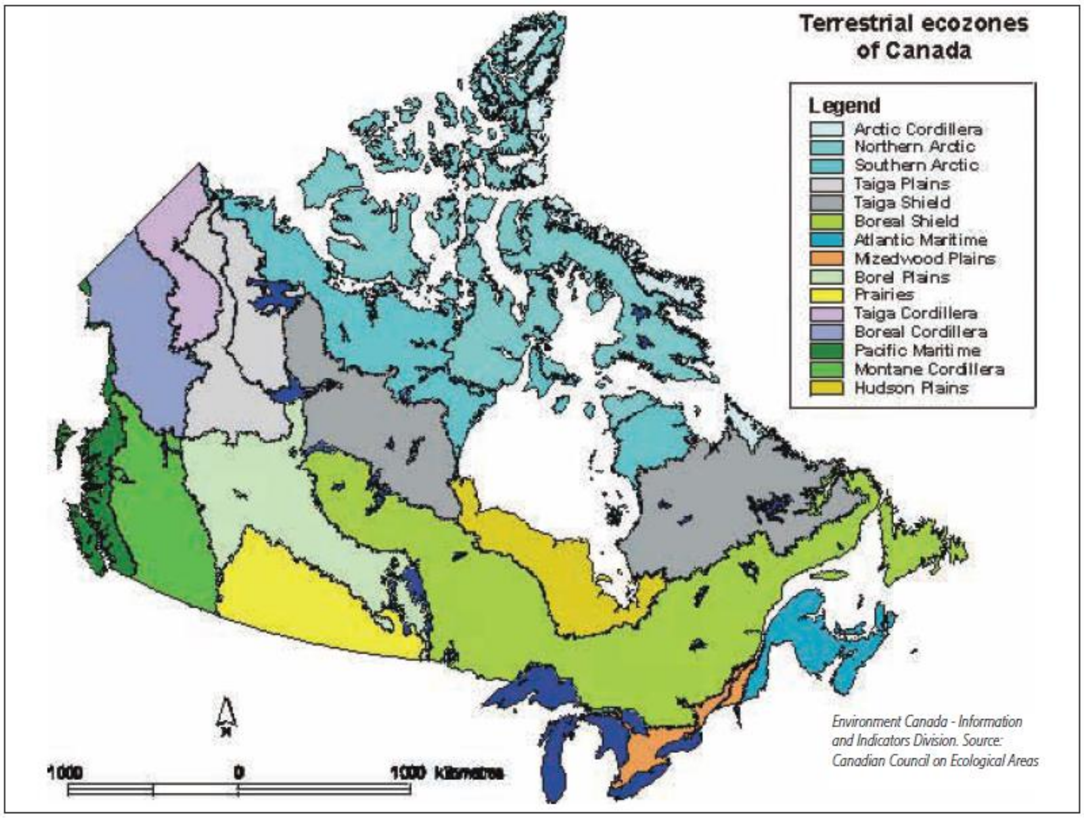
UNFCCC, 2005. Tool for the Demonstration and Assessment of Additionality in A/R Cdm Project Activities. Clean Development Mechanism Executive Board, Meeting Report #21, Annex 16. http://cdm.unfccc.int/EB/021/eb21repan16.pdf

White, R.G., C.L. Bowling, W.J. Parton and W.D. Towill. 2005. Well-spaced free-growing regeneration of the Canadian Forest Sector (CBM-CFS3) Version 1.0: Draft User's Guide. Personal communication.

Appendix A- Allometric Equations

Figure A1 shows the terrestrial ecozones of Canada (Environment Canada, 1996; *Kull et al, 2006*), by which the biomass expansion factors (Table A1) and root-shoot ratios (Table A2) shown below are organized.

Figure A1. The Terrestrial Ecozones of Canada (Environment Canada, 1996; *Kull et al., 2006*).



BEF (t/ m^3) convert merchantable volume (m^3/ha) to above-ground biomass (t/ha). All factors standardized to 100 m^3/ha. BEF derived from CBM-CFS3 (*Kurz et al, 2009*). Volumes are net merchantable for British Columbia; all other jurisdictions use gross merchantable volume. Source:

Kurz, W.A., Dymond, C.C., White, T.M., Stinson, G., Shaw, C.H., Rampley, G.J., Smyth, C., Simpson, B.N., Neilson, E.T., Trofymow, J.A., Metsaranta, J., Apps, M.J. 2009. CBM-CFS3: A model of carbon-dynamics in forestry and land-use change implementing IPCC standards, Ecological Modelling, 220: 480–504, doi:10.1016/j.ecolmodel.2008.10.018.Note that the "Other Hardwood" column in Tables A1 and A2 is appropriate for intolerant hardwoods such as birch and poplar, but is too low for tolerant and mid tolerant hardwoods such as maple, cherry, and beech. For such species, a factor of 1.64 was used by *Freedman and Keith (1995)*.

Table A1. Stand level BEF for different regions and species in Canada. BEF convert merchantable volume (m^3/ha) to biomass (t/ha). All factors standardized to 100 m^3/ha.

	Region	Species				
Province	Terrestrial Ecozone	Hybrid poplar	Pine	Spruce	Other HW	Other SW
AB	Boreal Plains	1.08	1.05	1.20	1.26	1.09
AB	Boreal Shield West	1.11	1.09	1.09	1.11	1.09
AB	Montane Cordillera	0.95	1.20	1.21	1.26	1.18
AB	Prairies	1.11	1.09	1.09	1.26	1.09
AB	Taiga Plains	0.99	0.86	0.94	0.99	0.98
AB	Taiga Shield West	0.99	0.98	0.98	0.99	0.98
BC	Boreal Cordillera	1.67	1.26	1.34	1.35	1.36
BC	Boreal Plains	1.48	1.11	1.09	1.42	1.08
BC	Montane Cordillera	1.56	1.19	1.19	1.55	1.48
BC	Pacific Maritime	1.54	2.08	1.43	1.47	1.72
BC	Taiga Plains	1.37	0.90	1.09	1.29	1.02
Lab.	Boreal Shield East	0.95	1.16	1.08	0.95	1.16
Lab.	Taiga Shield East	0.95	1.01	0.81	0.95	1.01
MB	Boreal Plains	0.71	0.69	0.79	0.71	0.75
MB	Boreal Shield West	0.78	0.68	0.80	0.79	0.73
MB	Hudson Plains	0.79	0.73	0.73	0.79	0.73
MB	Prairies	0.71	0.75	0.75	0.71	0.75
MB	Taiga Shield West	0.79	0.73	0.73	0.79	0.73
NB	Atlantic Maritime	1.03	0.83	0.88	1.04	0.82
Nfld.	Boreal Shield East	0.95	1.16	1.08	0.95	1.16
NS	Atlantic Maritime	0.93	1.52	0.86	1.13	0.88
NU	Hudson Plains	0.95	0.80	0.80	0.95	0.80
NU	Taiga Shield West	0.85	0.90	0.90	0.85	0.90
NWT	Boreal Cordillera	0.93	0.88	0.88	0.93	0.88
NWT	Boreal Plains	1.11	1.09	1.09	1.11	1.09
NWT	Taiga Cordillera	0.93	0.88	0.88	0.93	0.88
NWT	Taiga Plains	0.85	0.90	0.90	0.85	0.90
NWT	Taiga Shield West	0.85	0.90	0.90	0.85	0.90
ON	Boreal Shield East	0.79	0.74	0.82	0.78	0.77
ON	Boreal Shield West	0.79	0.74	0.82	0.78	0.77
ON	Hudson Plains	0.95	0.80	0.80	0.95	0.80
ON	Mixedwood Plains	0.84	0.69	0.69	0.84	0.69
PEI	Atlantic Maritime	0.94	0.84	0.81	1.06	0.84
QC	Atlantic Maritime	0.89	0.75	0.86	1.06	0.87
QC	Boreal Shield East	0.84	0.71	0.82	0.98	0.81
QC	Hudson Plains	0.95	0.80	0.83	0.95	0.80
QC	Mixedwood Plains	0.84	0.74	0.91	0.94	0.78
QC	Taiga Shield East	0.95	0.80	0.80	0.95	0.80
SK	Boreal Plains	0.78	0.74	0.85	0.79	0.83
SK	Boreal Shield West	0.79	0.81	0.84	0.79	0.84
SK	Taiga Shield West	0.79	0.73	0.73	0.79	0.73
SK	Prairies	0.71	0.75	0.75	0.71	0.75
YT	Boreal Cordillera	0.95	0.88	0.87	0.93	0.88
YT	Pacific Maritime	1.47	1.72	1.72	1.47	1.72
YT	Taiga Cordillera	0.93	0.88	0.88	0.93	0.88
YT	Taiga Plains	1.29	1.02	1.02	1.29	1.02

Root-to-shoot ratios for all provinces and ecozones are listed in Table A2. The root:shoot ratio (t/m^3) is used to convert merchantable volume (m^3/ha) to below-ground (i.e., roots) biomass in t/ha. All factors standardized to 100 m^3/ha. R:S derived from CBM-CFS3 (Kurz *et al,* 2009). Volumes are net merchantable for British Columbia; all other jurisdictions use gross merchantable volume. Source: Kurz, W.A., Dymond, C.C., White, T.M., Stinson, G., Shaw, C.H., Rampley, G.J., Smyth, C., Simpson, B.N., Neilson, E.T., Trofymow, J.A., Metsaranta, J., Apps, M.J. 2009. CBM-CFS3: A model of carbon-dynamics in forestry and land-use change implementing IPCC standards, Ecological Modelling, 220: 480–504, doi:10.1016/j.ecolmodel.2008.10.018.

To determine root biomass (t/ha), multiply merchantable volume of the stand (m^3/ha) by the root-to-shoot ratio. For reference purposes, the Terrestrial Ecozones of Canada are shown in Figure A1 below:

Table A2. Stand level root-to-shoot ratios for different regions and species in Canada. Root-to-shoot ratios convert merchantable volume (m^3/ha) to biomass (t/ha). All factors standardized to 100 m^3/ha

Region		Species				
Province	Terrestrial Ecozone	Hybrid poplar	Pine	Spruc	Other HW	Other SW
AB	Boreal Plains	0.28	0.23	0.27	0.31	0.24
AB	Boreal Shield West	0.29	0.24	0.24	0.29	0.24
AB	Montane Cordillera	0.26	0.27	0.27	0.31	0.26
AB	Prairies	0.29	0.24	0.24	0.31	0.24
AB	Taiga Plains	0.27	0.19	0.21	0.27	0.22
AB	Taiga Shield West	0.27	0.22	0.22	0.27	0.22
BC	Boreal Cordillera	0.37	0.28	0.30	0.3	20.30
BC	Boreal Plains	0.34	0.25	0.24	0.33	0.24
BC	Montane Cordillera	0.35	0.26	0.26	0.35	0.33
BC	Pacific Maritime	0.35	0.46	0.32	0.34	0.38
BC	Taiga Plains	0.33	0.20	0.24	0.31	0.23
Lab.	Boreal Shield East	0.26	0.26	0.24	0.26	0.26
Lab.	Taiga Shield East	0.26	0.22	0.18	0.26	0.22
MB	Boreal Plains	0.22	0.15	0.18	0.22	0.17
MB	Boreal Shield West	0.23	0.15	0.18	0.23	0.16
MB	Hudson Plains	0.23	0.16	0.16	0.23	0.16
MB	Prairies	0.22	0.17	0.17	0.22	0.17
MB	Taiga Shield West	0.23	0.16	0.16	0.23	0.16
NB	Atlantic Maritime	0.27	0.18	0.19	0.27	0.18
Nfld.	Boreal Shield East	0.26	0.26	0.24	0.26	0.26
NS	Atlantic Maritime	0.26	0.34	0.19	0.29	0.19
NU	Hudson Plains	0.26	0.18	0.18	0.26	0.18
NU	Taiga Shield West	0.24	0.20	0.20	0.24	0.20
NWT	Boreal Cordillera	0.26	0.19	0.19	0.26	0.19
NWT	Boreal Plains	0.29	0.24	0.24	0.29	0.24
NWT	Taiga Cordillera	0.26	0.19	0.19	0.26	0.19
NWT	Taiga Plains	0.24	0.20	0.20	0.24	0.20
NWT	Taiga Shield West	0.24	0.20	0.20	0.24	0.20
ON	Boreal Shield East	0.23	0.16	0.18	0.23	0.17
ON	Boreal Shield West	0.23	0.16	0.18	0.23	0.17
ON	Hudson Plains	0.26	0.18	0.18	0.26	0.18
ON	Mixedwood Plains	0.24	0.15	0.15	0.24	0.15
PEI	Atlantic Maritime	0.26	0.19	0.18	0.28	0.19
QC	Atlantic Maritime	0.25	0.17	0.19	0.28	0.19
QC	Boreal Shield East	0.24	0.16	0.18	0.27	0.18
QC	Hudson Plains	0.26	0.18	0.18	0.26	0.18
QC	Mixedwood Plains	0.24	0.16	0.20	0.26	0.17
QC	Taiga Shield East	0.26	0.18	0.18	0.26	0.18
SK	Boreal Plains	0.23	0.16	0.19	0.23	0.18
SK	Boreal Shield West	0.23	0.18	0.19	0.23	0.19
SK	Taiga Shield West	0.23	0.16	0.16	0.23	0.16
SK	Prairies	0.22	0.17	0.17	0.22	0.17
YT	Boreal Cordillera	0.26	0.19	0.19	0.26	0.19
YT	Pacific Maritime	0.34	0.38	0.38	0.34	0.38
YT	Taiga Plains	0.31	0.23	0.23	0.31	0.23
YT	Taiga Cordillera	0.26	0.19	0.19	0.26	0.19

Appendix B – Wood Density by Species

Source of wood density data:
Forest Products Laboratory, 1999, *Wood handbook—Wood as an engineering material.* Gen. Tech. Rep. FPL–GTR–113. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 463p. http://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr113/fplgtr113.htm

The following density values (converted from specific gravities) for a selection of species, and additional data may be found in the above reference. The data is for green wood and are taken from Chapter 4 of the above-noted reference, Tables 4-3a and 4.4a. The data on woods grown in Canada originally came from: Kennedy, E.I., 1965, *Strength and related properties of woods grown in Canada.* Government of Canada, Department of Forestry, Headquarters, Ottawa, Ontario. Department of Forestry Publication 1104.

Species	Density (t/m^3)
Trembling aspen	0.37
Black cottonwood	0.30
Willow (US)	0.39
White birch	0.51
Sugar maple	0.60
White ash	0.57
Red oak	0.58
Black walnut	0.55
Balsam fir	0.34
Lodgepole pine	0.40
Ponderosa pine	0.44
Red pine	0.39
Jack pine	0.42
White pine (eastern & western)	0.36
White spruce	0.35
Douglas-fir	0.45
Western larch	0.55
Western red cedar	0.31
Tamarack	0.48

If the species planted is not included in the listed references, then the following “default” densities may be used:

Softwoods and hybrid poplars	0.37
Deciduous hardwoods	0.60

Appendix C –Definitions of Key Terms

Above-Ground Live Biomass

Live trees including the stem, branches, leaves or needles, brush and other woody live plants above ground.

Additionality

Forest project practices that exceed the baseline characterization, including any applicable mandatory land use laws and regulations.

Allometric equation

An equation that utilizes the genotypical relationship among tree components to estimate characteristics of one tree component from another. Allometric equations allow the below-ground root volume to be estimated using the above-ground bole volume.

Baseline Activity

The volume/biomass of harvest, inventory and growth of forests and forest products associated.

Biological emissions

For the purposes of the forest Protocol, biological emissions are GHG emissions that are released directly from forest biomass, both live and dead, including forest soils. In the first three years of reporting the only biological emission type that is required to be reported for forest entities and projects is CO_2, as identified in the Quantification Section of the Protocol. Biological emissions are deemed to occur when the reported tonnage of carbon stocks decline at the project level.

Biomass Expansion Factor

A scientifically established factor which when applied to a tree can convert a readily measurable entity (e.g. volume) into an estimate of biomass, either above-ground or below-ground.

Biomass

The total mass of living organisms in a given area or volume; recently dead plant material is often included as dead biomass.

Bole

A trunk or main stem of a tree.

Carbon Pool

A reservoir that has the ability to accumulate and store carbon or release carbon. In the case of forests, a carbon pool is the forest biomass, which can be subdivided into smaller pools. These pools may include above-ground or below-ground biomass or harvested wood products, among others.

Carbon Reservoir

Physical unit or component of the biosphere, geosphere or hydrosphere with the capacity to store or accumulate carbon removed from the atmosphere by a sink or a carbon captured from a source. This refers to either naturally occurring areas that have the ability to hold carbon or manmade areas.

Carbon Sink

Physical unit or process that removes a GHG from the atmosphere.

Carbon Source

Physical unit or process that releases carbon into the atmosphere.

Carbon Stocks

The carbon contained in identified forest biomass categories (i.e. carbon pools), such as above and below-ground biomass.

De minimis

The emissions associated with a carbon pool at any point during the project life is so minor as to merit disregard; defined as less than or equal to 5% on a cumulative basis for total carbon stocks.

Downed woody debris

Any piece(s) of dead woody material from a tree, e.g. dead boles, limbs, and large root masses, on the ground in forest stands. The Reserve requires the carbon in lying dead biomass with a minimum diameter of six inches to be measured.

Direct emissions

Greenhouse gas emissions from sources that are owned or controlled by the reporting entity.

Forest Management

The commercial or non-commercial growing and harvesting of forests.

Forest Project

A planned set of activities to remove, reduce or prevent carbon dioxide emissions in the atmosphere by conserving and/or increasing forest carbon stocks

Forest project baseline

A long-term forecast of the forest practices (or absence thereof) that would have occurred within a project's boundaries in the absence of the project activity.

Forest project greenhouse gas reduction

Removals or reductions of $CO_2$and prevented CO_2 emissions resulting from Reserve-approved forest projects. GHG reductions are calculated as gains in carbon stocks over time relative to the project baseline.

Free-to-Grow

A condition in which a forest is considered established based on a minimum stocking standard, a minimum height and freedom from competition that could impede growth.

Good Practices Guidance

A practice or usually a combination of practices that are determined by a survey of experts to be the most effective and practicable means (including technological, economic, and institutional considerations) of undertaking the intended operation. In 2003, the IPCC released a widely-used good practice guide for land use, land use change and forestry projects.

GHG Assessment Boundary

Encompasses all primary and significant secondary effects associated with the project activities.

GHG Reductions

See forest project greenhouse gas reduction. Greenhouse Gases

(GHG)

For the purposes of the Reserve, GHGs are the six gases identified in the Kyoto Protocol: Carbon Dioxide (CO_2), Nitrous Oxide(N20), Methane(CH4), Hydroflourocarbons (HFCs), Perflourocarbons (PFCs), and Sulphur Hexafluoride(SF6).

Grossly Negligent

Conscious and voluntary disregard of the need to use reasonable care, which is likely to cause foreseeable grave injury or harm to persons, property, or both.

Wet Lands

Land that is saturated with water long enough to promote aquatic processes such as hydrophytic vegetation. This may include land seasonally flooded.

Appendix D: List of Acronyms

A/R ....Afforestation/ Reforestation

BEF ....Biomass Expansion Factor

CCAR...California Climate Action Registry

CFS ....Canadian Forest Service

CO_2..Carbon Dioxide

FM ....Forest Management

GHG..Greenhouse Gas

HWP..Harvested Wood Products

IPCC...Intergovernmental Panel on Climate Change

LULUCF ....Land Use, Land Use Change and Forestry

N_2O..Nitrous Oxide

OC ....Offset Credits

OSP... ....Offset System Protocol

QA/QC..Quality Assurance/Quality Control

R/R ....Reductions and/or Removals

SOP ....Standard Operating Procedure

SSR ....Sinks, Sources and Reservoirs