Forest Project Protocol

FINAL WORK GROUP DRAFT

Version 3.0

August 4, 2009

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Abbreviations and Acronyms

C	carbon
CH_4	methane
CO_2	carbon dioxide
CRT	Climate Reserve Tonne
FIA	Forest Inventory Assessment [http://fia.fs.fed.us/program-features/rpa/]
FPP	Forest Project Protocol
FRAP	CalFire Fire and Resource Assessment Program
FVP	Forest Verification Protocol
GHG	greenhouse gas
lb	pound
IFM	Improved Forest Management
N_2O	nitrous oxide
PF	Professional Forester, in the case of California a 'Registered Professional Forester'
PIA	Project Implementation Agreement
Reserve	Climate Action Reserve
RPF	Registered Professional Forester, a person registered to practice professional forestry in California
USFS	United States Forest Service

1 Introduction

The Forest Project Protocol (FPP) provides requirements and guidance for quantifying the net climate benefits of activities that sequester carbon on forestland. The protocol provides project eligibility rules; methods to calculate a project's net effects on greenhouse gas (GHG) emissions and removals of CO_2 from the atmosphere ("removals"); procedures for assessing the risk that carbon sequestered by a project may be reversed (i.e. released back to the atmosphere); and approaches for long term project monitoring and reporting. The goal of this protocol is to ensure that the net GHG reductions and removals caused by a project are accounted for in a complete, consistent, transparent, accurate, and conservative manner and may therefore be reported to the Climate Action Reserve ("Reserve") as the basis for issuing carbon offset credits (called Climate Reserve Tonnes, or CRTs).

The Reserve is a national offsets program working to ensure integrity, transparency and financial value in the North American carbon market. It does this by establishing regulatory-quality standards for the development, quantification and verification of GHG emissions reduction projects in North America; issuing carbon offset credits known as Climate Reserve Tonnes (CRTs) generated from such projects; and tracking the transaction of credits over time in a transparent, publicly-accessible system. Adherence to the Reserve's high standards ensures that emissions reductions associated with projects are real, permanent and additional, thereby instilling confidence in the environmental benefit, credibility and efficiency of the U.S. carbon market.

The Climate Action Reserve operates as a program under the similarly named nonprofit organization. Two other programs, the Center for Climate Action and the California Climate Action Registry, also operate under the Climate Action Reserve.

Only those Forest Projects that are eligible under and comply with the FPP may be registered with the Reserve. A separate, but related protocol, the Reserve's Forest Verification Protocol (FVP), provides requirements and guidance for verifying the performance of project activities and their associated GHG reductions and removals reported to the Reserve.

1.1 About Forests, Carbon Dioxide, and Climate Change

Forests have the capacity to both emit and sequester carbon dioxide (CO_2), a leading greenhouse gas that contributes to climate change. Trees, through the process of photosynthesis, naturally absorb CO_2 from the atmosphere and store the gas as carbon in their biomass, i.e. trunk (bole), leaves, branches, and roots. Carbon is also stored in the soils that support the forest, as well as the understory plants and litter on the forest floor. Wood products that are harvested from forests can also provide long term storage of carbon.

When trees are disturbed, through events like fire, disease, pests or harvest, some of their stored carbon may oxidize or decay over time releasing CO_2 into the atmosphere. The quantity and rate of CO_2 that is emitted may vary, depending on the particular circumstances of the disturbance. Forests function as reservoirs in storing CO_2. Depending on how forests are managed or impacted by natural events, they can be a net source of emissions, resulting in a decrease to the reservoir, or a net sink, resulting in an increase of CO_2 to the reservoir. In other words, forests may have a net negative or net positive impact on the climate.

Through sustainable management and protection, forests can also play a positive and significant role to help address global climate change. The Reserve's FPP is designed to

address the forest sector's unique capacity to sequester, store, and emit CO_2 and to facilitate the positive role that forests can play to address climate change.

1.2 About Version 3.0 of the Forest Project Protocol

This version of the Forest Project Protocol (Version 3.0, August 2009) is the result of over 20 months of discussion by a dedicated workgroup. The multi-stakeholder workgroup began meeting with the explicit task of updating the forest protocols to:

- Allow greater landowner participation, particularly publicly-owned lands and industrial working forests.
- Make improvements to the protocol's clarity, accuracy, conservativeness, environmental integrity, and cost-effectiveness (where doing so does not infringe on other principles).

Additionally, this version of the protocol is designed so that it can be applied to projects outside the state of California.

The Reserve uses a rigorous, transparent, and comprehensive process for developing all of its protocols, focusing on accurate and conservative accounting to ensure that credits are issued only for GHG reductions and removals that are real, permanent, additional, verifiable, and enforceable by contract. The Reserve may update the FPP from time to time to reflect new scientific findings or policy decisions. For additional information about the update process and further news on future updates, please visit the Reserve website at www.climateactionreserve.org.

The Reserve continues to fully support projects registered under previous versions of the forest protocol and strongly believes that the GHG reductions and removals quantified for such projects will continue to meet the highest standards today and into the future. Forest Projects that are registered under previous versions of the FPP may continue to be verified under the version of the FPP in place at the time they were registered.

2 Forest Project Definitions and Requirements

For the purposes of the FPP, a Forest Project is a planned set of activities designed to increase removals of CO_2 from the atmosphere, or reduce or prevent emissions of CO_2 to the atmosphere, through increasing and/or conserving forest carbon stocks.

A glossary of terms related to Forest Projects is provided in Section 11 of this protocol. Throughout the protocol, important defined terms are capitalized (e.g. "Reforestation Project").

2.1 Project Types

The Reserve will register the following types of Forest Project activities.

2.1.1 Reforestation

A Reforestation Project involves restoring tree cover on land that is not at optimal stocking levels and has minimal short-term (30-year) commercial opportunities. A Reforestation Project is only eligible if:

1. The project involves tree planting on land that:
    a. Has had less than 10 percent tree canopy cover for a minimum of 10 years; or

   b. Has been subject to a Significant Disturbance that has removed at least 20 percent of the land's above-ground live biomass.[1]
2. No harvesting of pre-existing carbon in live trees occurs during the first 30 years after the project start date unless such harvesting is needed to prevent or reduce an imminent threat of disease. Such harvesting may only occur if the Forest Owner provides the Reserve with a written statement from the government agency in charge of forestry regulation in the state where the project is located stipulating that the harvesting is necessary to prevent or mitigate disease.
3. The tree planting does not follow a commercial harvest that has occurred within the past 10 years that has not been affected by a Significant Disturbance.
4. The project does *not* employ broadcast fertilization.

Reforestation Projects may be eligible on both private and public lands.

2.1.2 Improved Forest Management

An Improved Forest Management Project involves management activities that maintain or increase carbon stocks on forested land relative to baseline levels of carbon stocks, as defined in Section 6.2 of this protocol. An Improved Forest Management Project is only eligible if:

1. The project takes place on land that has greater than 10 percent tree canopy cover.
2. The project employs natural forest management practices, as defined in Section 3 of this protocol.
3. The project does *not* employ broadcast fertilization.

Eligible management activities may include, but are not limited to:

- Increasing the overall age of the forest by increasing rotation ages.
- Increasing the forest productivity by thinning diseased and suppressed trees.
- Managing competing brush and short-lived forest species.
- Increasing the stocking of trees on understocked areas.

Improve Forest Management Projects may be eligible on both private and public lands.

2.1.3 Avoided Conversion

An Avoided Conversion Project involves preventing the conversion of forestland to a non-forest land use by dedicating the land to continuous forest cover through a conservation easement or transfer to public ownership. An Avoided Conversion Project is only eligible if:

1. The Forest Owner can demonstrate that there is a significant threat of conversion of project land to a non-forest land use by following the requirements for establishing the project's baseline in Section 6.3 of this protocol.
2. The project does *not* employ broadcast fertilization.

An Avoided Conversion Project may involve tree planting and harvesting as part of the project activity.

Avoided Conversion Projects are eligible only on lands that are privately owned prior to project initiation.

[1] Note: Records or evidence must be available to document a Significant Disturbance if it is more that 10 years old. Project Start Date must be no earlier than 2001. See Project Start Date section 3.2

2.2 Forest Owners

A Forest Owner is a corporation or other legally constituted entity, city, county, state agency, individual, or a combination thereof that executes the Project Implementation Agreement (see Section 3.5). Generally, a Forest Owner is the owner in fee of the property involved in a Forest Project. In some cases, one entity may be the owner in fee while another entity may have an interest in the trees or the timber on the property, in which case the Reserve will make a determination as to whether both entities are required to execute the Project Implementation Agreement and thereby collectively be considered the Forest Owner.

In some cases, the Reserve may determine that an entity or individual that is not the owner in fee nonetheless does have a complete and perpetual interest in the trees on the property that allows for complete management of the trees and sufficient access rights to the property, such that it is the appropriate entity to execute the Project Implementation Agreement. In these cases, such an entity or individual may be defined as the Forest Owner, on the condition that it makes additional contributions of CRTs to the Reserve's Buffer Pool (see Section 7.2). The assignment provisions of the Project Implementation Agreement explain when and how a party to the agreement may assign its obligations thereunder.

The Forest Owner is responsible for undertaking a Forest Project and registering it with the Reserve, and is ultimately responsible for all Forest Project reporting and attestations. The Forest Owner may, however, engage an independent third-party project developer to assist or consult with the Forest Owner and to designate and implement the Forest Project. All information submitted to the Reserve on behalf of the Forest Owner shall reference the Forest Owner, who is ultimately responsible for the accuracy and completeness of the information submitted.

3 Eligibility Rules and Other Requirements

In addition to the definitions and requirements described in Section 2, Forest Projects must meet several other criteria and conditions to be eligible for registration with the Reserve, and must adhere to certain requirements related to their duration and crediting periods.

3.1 Additionality

The Reserve strives to register only projects that yield surplus GHG emission reductions and removals that are additional to what would have occurred in the absence of a carbon offset market (i.e. under "Business As Usual"). For a general discussion of the Reserve's approach to determining additionality, see the Reserve's Program Manual (available at http://www.climateactionreserve.org/how-it-works/program/program-manual/).

Forest Projects must satisfy the following tests to be considered additional:

1. *Legal requirement test*. Forest Projects must achieve GHG reductions or removals above and beyond any GHG reductions or removals that would result from compliance with any federal, state, or local law, statute, rule, regulation, or ordinance. Forest Projects must also achieve GHG reductions and removals above and beyond any GHG reductions or removals that would result from compliance with any court order or other legally binding mandates, including conservation easements or deed restrictions, except where such conservation easements or deed restrictions have been enacted in support of the Forest Project, as described in Section 3.6.

2. *Performance test*. Forest Projects must achieve GHG reductions or removals above and beyond any GHG reductions or removals that would result from engaging in "Business As Usual" activities, as defined by the requirements described below (Section 3.1.2).

3.1.1 Legal Requirement Test

The legal requirement test is satisfied if the following requirements are met, depending on the type of Forest Project:

3.1.1.1 Reforestation Projects

The Forest Owner must sign the Reserve's Regulatory Attestation Form indicating that reforestation activities are not required by law.

Modeling of the project's baseline carbon stocks must reflect all legal constraints, as required in Section 6.1 of this protocol.

3.1.1.2 Improved Forest Management Projects

The Forest Owner must sign the Reserve's Regulatory Attestation Form indicating that the Forest Project's additionality resulting from planned management activities is not required by law.

Modeling of the project's baseline carbon stocks must reflect all legal constraints, as required in Section 6.2 of this protocol.

3.1.1.3 Avoided Conversion Projects

The Forest Owner must sign the Reserve's Regulatory Attestation Form indicating that the Forest Project's planned forest conservation activities are not required by law.

Modeling of the project's baseline carbon stocks must reflect all legal constraints, as required in Section 6.3 of this protocol.

The Forest Owner must provide documentation demonstrating that the type of anticipated land use conversion is legally permissible. Such documentation must fall into at least one of the following categories:

1. Documentation indicating that the current land use policies, including zoning and general plan ordinances, and other local and state statutes and regulations, permit the anticipated type of conversion.
2. Documentation indicating that the Forest Owner has obtained all necessary approvals from the governing county to convert the Project Area to the proposed type of non-forest land use (including, for instance, certificates of compliance, subdivision approvals, timber conversion permits, other rezoning, major or minor use permits, etc.).
3. Documentation indicating that similarly situated forestlands within the project's Assessment Area were recently able to obtain all necessary approvals from the governing county, state, or other governing agency to convert to a non-forest land use (including, for instance, certificates of compliance, subdivision approvals, timber conversion permits, other rezoning, major or minor use permits, etc.).

3.1.2 Performance Test

The performance test is satisfied if the following requirements are met, depending on the type of Forest Project:

3.1.2.1 Reforestation Projects

A Reforestation Project that occurs on land that has had less than 10 percent tree canopy cover for at least 10 years automatically satisfies the performance test.

A Reforestation Project that occurs on land that has undergone a Significant Disturbance satisfies the performance test if:

1. The Forest Project corresponds to a scenario in Appendix E, Table E.1, indicating that it is "eligible" (as determined by the guidance in Appendix E); or
2. The Forest Project occurs on a type of land for which the Forest Owner has not historically engaged in or allowed timber harvesting. (Examples of such land include municipal or state parks.)

3.1.2.2 Improved Forest Management Projects

An Improved Forest Management Project automatically satisfies the performance test. (Project activities are considered additional to the extent they produce GHG reductions and/or removals in excess of those that would have occurred under a Business As Usual scenario, as defined by the baseline estimation requirements in Section 6.2.1.)

3.1.2.3 Avoided Conversion Projects

An Avoided Conversion Project satisfies the performance test if the Forest Owner provides a real estate appraisal for the Project Area (as defined in Section 4) indicating the following:

1. *The Project Area is suitable for conversion*. The appraisal must clearly identify the highest value alternative land use for the Project Area and indicate how the physical characteristics of the Project Area are suitable for the alternative land use.
    a. At a minimum, where conversion to commercial, residential, or agricultural land uses is anticipated, the appraisal must indicate that the slope of Project Area land does not exceed 40 percent.
    b. Where conversion to agricultural land use is anticipated, the appraisal must provide:
        i. Evidence of soil suitability for the type of expected agricultural land use.
        ii. Evidence of water availability for the type of expected agricultural land use.
    c. Where conversion to mining land use is anticipated, the appraisal must provide evidence of the extent and amount of mineral resources existing in the Project Area.
    d. The appraisal must identify specific portions of the Project Area suitable for the identified alternative land use. (For example, an appraisal that identified a golf course as an alternative land use must specify the approximate acres suitable for fairways, greens, clubhouses, and outbuildings.)
2. *The alternative land use for the Project Area has a higher market value than forestland*. The appraisal for the property must demonstrate that the fair market value of the anticipated alternative land use for the Project Area is at least 40 percent greater than the value of the current forested land use.

Where conversion to residential, commercial, or recreational land uses is anticipated, the appraisal must also describe the following information:

1. The proximity of the Project Area to metropolitan areas.
2. The proximity of the Project Area to grocery and fuel services and accessibility of those services.
3. Population growth within 180 miles of the Project Area.

The appraisal must be conducted in accordance with the Uniform Standards of Professional Appraisal Practice[2] and the appraiser must meet the qualification standards outlined in the Internal Revenue Code, Section 170 (f)(11)(E)(ii).[3]

3.2 Project Start Date

The start date of a Forest Project is the date on which an activity is initiated that will lead to increased GHG reductions or removals relative to the Forest Project's baseline. The following actions identify the project start date for each project type:

- For a Reforestation Project, the action is the planting of trees, or site preparation for the planting of trees, whichever comes first.
- For an Improved Forest Management Project, the action is initiating forest management activities that increase sequestration and/or decrease emissions relative to the baseline.
- For an Avoided Conversion Project, the action is committing the Project Area to continued forest management and protection through recording a conservation easement or transferring the Project Area to public ownership.

For a period of 12 months following the posting on the Reserve's website of Assessment Area data for a particular state or region (see Appendix F), the Reserve will list projects in that state or region with start dates as early as January 1, 2001. After the 12 month period, projects must be listed on the Reserve within 6 months of their project start date.[4]

3.3 Crediting Period

The baseline for any Forest Project registered with the Reserve under this version of the Forest Project Protocol is assumed to be valid for 100 years. This means that a registered Forest Project will be eligible to receive CRTs for GHG reductions and/or removals quantified using this protocol, and verified by Reserve approved verification bodies, for a period of 100 years following the project's start date.

3.4 Minimum Time Commitment

Forest Owners must monitor and verify a Forest Project for a period of 100 years following the issuance of any CRT for GHG reductions or removals achieved by the project. For example, if CRTs are issued to a Forest Project in year 99 following its start date, monitoring and verification activities must be maintained until year 199. All projects must undergo an initial verification at the time the project is submitted. Subsequent monitoring reports for Improved Forest Management Projects and Avoided Conversion Projects must be verified and submitted annually to the Reserve, and the project must undergo a site verification at least once every six years. Reforestation Projects may defer subsequent monitoring and verification activities until

[2] The Uniform Standards of Professional Appraisal Practice may be accessed at http://commerce.appraisalfoundation.org/html/2006%20USPAP/toc.htm.

[3] Section 170 (f)(11)(E) of the Internal Revenue Code defines a qualified appraiser as
"an individual who:
(I) has earned an appraisal designation from a recognized professional appraiser organization or has otherwise met minimum education and experience requirements set forth in regulations prescribed by the Secretary,
(II) regularly performs appraisals for which the individual receives compensation, and
(III) meets such other requirements as may be prescribed by the Secretary in regulations or other guidance."

[4] See the Reserve's Program Manual for requirements for listing a project with the Reserve, available at http://www.climateactionreserve.org/how-it-works/program/program-manual/.

the Forest Owner wishes to verify project stocks, after which the periodic monitoring and verification activities described above apply.

There are three possible exceptions to this minimum time commitment:

1. A Forest Project automatically terminates if a Significant Disturbance occurs,[5] leading to an Unavoidable Reversal that reduces the project's standing live-tree carbon stocks below the project's baseline standing live-tree carbon stocks. Once a Forest Project terminates in this manner, the Forest Owner has no further obligations to the Reserve.
2. A Forest Project may be voluntarily terminated prior to the end of its minimum time commitment if the Forest Owner retires a quantity of CRTs, as specified under 'Retiring CRTs Following Project Termination,' below.
3. A Forest Project may be automatically terminated if there is a breech of certain terms described within the Project Implementation Agreement. Such a termination will require the Forest Owner to retire a quantity of CRTs, as specified under 'Retiring CRTs Following Project Termination,' below.

Retiring CRTs Following Project Termination

a. For a Reforestation or Avoided Conversion Project, the Forest Owner must retire a quantity of CRTs from its Reserve account equal to the total number of CRTs issued to the project over the preceding 100 years.
b. For an Improved Forest Management Project, the Forest Owner must retire a quantity of CRTs from its Reserve account equal to the total number of CRTs issued to the project over the preceding 100 years, multiplied by the appropriate compensation rate indicated in Table 3.1.
c. In addition:
    i. The retired CRTs must be those that were issued to the Forest Project, or that were issued to other Forest Projects registered with the Reserve.
    ii. The retired CRTs must be designated in the Reserve's software system as compensating for the Avoidable Reversal.

Table 3.1. Compensation Rate for Terminated Improved Forest Management Projects

Number of years that have elapsed between the start date and the date of termination	Compensation Rate
0-5	1.40
6-10	1.20
11-20	1.15
21-30	1.10
31-50	1.05
>50	1.00

3.5 Project Implementation Agreement

For a Forest Project to be eligible for registration with the Reserve, the Forest Owner is required to enter into a Project Implementation Agreement (PIA) with the Reserve. The PIA is an agreement between the Reserve and a Forest Owner setting forth: (i) the Forest Owner's obligation (and the obligation of its successors and assigns) to comply with the Forest Project

[5] The natural disturbance shall not be the result of intentional or grossly negligent acts of the Forest Owner.

Protocol, and (ii) the rights and remedies of the Reserve in the event of any failure of the Forest Owner to comply with its obligations. The PIA must be signed by the Forest Owner before a project can be registered with the Reserve.

3.6 Use of Qualified Conservation Easements or Qualified Deed Restrictions

For Avoided Conversion Projects on private land, the Forest Owner must record a Qualified Conservation Easement against the project's property in order for the Forest Project to be eligible for registration with the Reserve. In addition, Qualified Conservation Easements or Qualified Deed Restrictions may be voluntarily employed with Reforestation Projects and Improved Forest Management Projects. Reforestation Projects and Improved Forest Management Projects that choose to employ Qualified Conservation Easements or Qualified Deed Restrictions have reduced obligations to the Reserve's CRT Buffer Pool, as described in Section 7 and Appendix D.

Qualified Conservation Easements and Qualified Deed Restrictions must be recorded no earlier than one year before a project's start date. If a Qualified Conservation Easement or Qualified Deed Restriction was recorded more than one year prior to the start date, the limits imposed by the easement or deed restriction on forest management activities must be considered as a legal mandate for the purpose of satisfying the "legal requirement" test for additionality (Section 3.1.1) and in determining the project's baseline (Section 6).

3.7 Attestation of Title

All Forest Owners must sign the Reserve's standard Attestation of Title form indicating that they have an exclusive ownership claim to the GHG reductions and removals achieved by their Forest Project. Copies of the Attestation of Title form are available on the Reserve's website. Please note that in requesting this form, the Reserve is not providing credit or acting as a broker to trade any Forest Project CRTs.

3.8 Project Location

All Forest Projects located in the United States of America are eligible to register with the Reserve, provided they meet all other eligibility requirements described in this protocol. Reforestation Projects and Improved Forest Management Projects may be located on private land, or on state or municipal public land. Avoided Conversion Projects must be implemented on private land, unless the land is transferred to public ownership as part of the project.

All Forest Projects on public lands must be approved by the government agency or agencies responsible for management activities on the land. This approval must include an explicit approval of the project's baseline, as determined in Section 6, and must involve any public vetting processes necessary to evaluate management and policy decisions concerning the project activity.

Forest Projects on federal lands may be eligible if and when their eligibility is approved through congressional processes. Forest Projects in tribal areas must demonstrate that the land within the Project Area is owned by a tribe or private entities.

Version 3.0 of the Forest Project Protocol contains data tables, equations, and benchmark data applicable to projects located in California. The Reserve will add approved equations and models for other U.S. states and regions as they are developed and/or reviewed.

The methods required by this protocol for estimating baseline carbon stocks for Forest Projects cannot currently be applied outside the United States, as they rely on U.S.-specific data sets and models.

3.9 Sustainable Harvesting and Natural Forest Management Practices

Forest Projects can create long-term climate benefits as well as provide other environmental benefits, including the sustaining of natural ecosystem processes. This protocol requires eligible projects to employ both sustainable harvesting practices and natural forest management practices, as described below.

3.9.1 Sustainable Harvesting Practices

At the time commercial harvesting is either planned or initiated within project boundaries, the Forest Owner must employ and demonstrate sustainable long-term harvesting practices on all of its forest landholdings, including the Project Area, using one of the following options:

1. The Forest Owner must be certified under either the Forest Stewardship Council, Sustainable Forestry Initiative, or Tree Farm System certification program, whose certification standards require adherence to and verification of harvest levels which can be permanently sustained over time; or
2. The Forest Owner must adhere to a renewable long-term management plan that demonstrates harvest levels which can be permanently sustained over time and that is sanctioned and monitored by a state or federal agency; or
3. The Forest Owner must employ uneven-aged silvicultural practices and canopy retention averaging at least 40 percent across the forest, as measured on any 20 acres within the entire forestland owned by the Forest Owner, including land within and outside of the Project Area. (Areas impacted by Significant Disturbance may be excluded from this test.)

Forest Owners who acquire new forest landholdings within their entity have up to 5 years to incorporate such acquisitions under their certification or management plan, whether or not such land is contiguous with the Project Area.

3.9.2 Natural Forest Management

All Forest Projects must promote and maintain a diversity of native species and utilize management practices that promote and maintain native forests comprised of multiple ages and mixed native species at multiple landscape scales ("Natural Forest Management").

All Forest Projects are required to establish and/or maintain forest types that are native to the Project Area. For the purposes of this protocol, native forests are defined as those forests occurring naturally in an area, as neither a direct nor indirect consequence of human activity post-dating European settlement.

Appendix F provides required references by Assessment Area for the definition of native forests. If a state/regional reference is unavailable or inadequate, the Forest Owner must provide documentation from a state botanist or other qualified independent resource, recognized as expert by academic, private and government organizations, indicating that the project employs native forests per the definition above. Where supported by scientific peer-reviewed research, the planting of native species outside of their current distribution is allowed as an adaptation

strategy due to climate change. Such planting must be done in accordance with a state or federally approved adaptation plan, or a local plan that has gone through a transparent public review process and has a written statement from the government agency in charge of forestry regulation in the state where the project is locating stipulating that the planting native trees outside their range is a favorable adaptation strategy amidst climate change.

Harvesting using even-age management must be conducted in stands no greater than 40 acres. Stands adjacent to recently harvested (even-age) stands must not be harvested using an even-aged regeneration harvest until a recent even-aged regeneration harvested stand is 5-years old, or the average height of the regeneration in the recently harvested stand has achieved a height of 5 feet. On a watershed scale up to 10,000 acres all projects must maintain, or make progress toward maintaining, no more than 40 percent of their forested acres in ages less than 20 years. Areas impacted by a Significant Disturbance are exempt from this test until any reforested areas affected by the Significant Disturbance achieve an age of 20 years.

The following key requirements shall apply to all Forest Projects regardless of the silvicultural or regeneration methods that are used to manage or maintain the forest:

1. Forest Projects must maintain or increase standing live carbon stocks over the project life, as described in Section 3.9.3.
2. Forest Projects must show verified progress (verified at scheduled site verifications) towards native tree species composition and distribution consistent with the forest type and forest soils native to the Assessment Area.
3. Forest Projects must manage the distribution of habitat/age classes and structural elements to support functional habitat for locally native plant and wildlife species naturally occurring in the Project Area.

Forest Projects that initially engage in Natural Forest Management must continue to do so for as long as monitoring and verification of the Forest Project are required by this protocol. Forest Projects that do not initially meet Natural Forest Management criteria but can demonstrate progress towards meeting these criteria at the times identified in Table 3.2 are eligible to register with the Reserve.

The evaluation worksheet provided in Table 3.2 shall be used to determine if the Forest Project meets the criteria for engaging in Natural Forest Management. The following evaluation must be completed and verified at a Forest Project's first verification and at all subsequent verifications. Forest Project carbon stock inventories (requirements for which are contained in Appendix A) should be used as the basis of these assessments where applicable.

Table 3.2. Evaluation criteria to test if a Forest Project meets the requirement for the establishment and maintenance of native species and natural forest management

Criteria	When Assessed	Results of not passing criteria	Application Rules
Native Species			
Project consists of at least 95% native species based on the sum of carbon in the standing live pool. The assessment shall be conducted using estimates of stems per acre for Reforestation Projects and basal area per acre for Improved Forest Management and Avoided Conversion Projects.	Assessed at first field verification from inventory data	Forest Project is not eligible unless demonstrated that management will achieve this goal over the project life.	Applies to all project types throughout the project life
	Assessment during field verification audits must demonstrate continuous progress toward goal. This criterion must be met within 50 years.	All of the Forest Project's Reserve account activity will be suspended until the criterion is met.	

Composition of Native Species			
Improved Forest Management and Avoided Conversion Projects Where the Project Area naturally consists of a mixed species distribution, no single species prevalence, measured as the percent of the basal area of all live trees in the Project Area, exceeds the percentage value of standing live carbon shown under the heading 'Composition of Native Species' in Appendix F. Where the Project Area does not naturally consist of a mixed species distribution, the Forest Owner may request a variance from this criterion prior to Registration. **Reforestation** To the extent seed is available, and/or physical site characteristics permit, Reforestation Projects must plant a mixture of species such that no single species prevalence, measured as the percent of all live tree stems in the Project Area, exceeds the percentage value shown under the heading 'Composition of Native Species' in the Assessment Area table in Appendix F. Where seed is unavailable or physical site characteristics are limiting, the Forest Owner may request a variance from the Reserve excepting the Forest Project from this criterion prior to registration.	Species composition is assessed at project initiation from inventory data	Project is not eligible, unless it is demonstrated that management activities will enable this goal to be achieved over the project life.	Applies to all project types throughout the project life Some project sites may not be capable of meeting the requirement. A variance to the requirement is allowed by written attestation stating that the species diversity is consistent with natural vegetation types for the assessment area. The attestation must be verified in the initial verification process.
	Species composition is assessed during project at each field verification audit Project must show continuous progress toward criteria. These criteria must be met within 50 years, except in cases where a variance has been granted at the initial verification, a Significant Disturbance has impacted species diversity, or natural mortality takes a project out of compliance.	Unless a variance has been granted, all of the project's Reserve account activity will be suspended until the criterion is met.	
Distribution of Age Classes/Sustainable Management			
All forest landholdings owned or controlled by the Forest Owner are currently under one of the following: 1. Third party certification under the Forest Stewardship Council ,Sustainable Forestry Initiative, or Tree Farm System in which the certification standards require adherence to and verification of harvest levels which can be permanently sustained over time, or 2. Operating under a renewable long-term management plan that demonstrates harvest levels which can be permanently sustained over time and that is sanctioned and monitored by a state or federal agency, or 3. The Forest Owner must employ uneven-aged silvicultural practices and canopy retention averaging at least 40 percent across the forest, as measured on any 20 acres within the entire forestland owned by the Forest Owner, including land within and outside of the Project Area. (Areas impacted by Significant Disturbance may be excluded from this test.)	Condition shall be met at all times during project and is assessed at each verification audit.	All Reserve account activity will be suspended until the criterion is met.	Applies to all project types at first regeneration harvest
On a watershed scale up to 10,000 acres all projects must maintain, or make progress toward maintaining, no more than 40 percent of their forested acres in ages less than 20 years. (Areas impacted by Significant Disturbance may be	Age classes (if even age management is used) are assessed at project initiation and each field verification audit.	NA	

excluded from this test.)	Age classes are assessed during project at each field verification audit. Project must show continuous progress toward criteria. This criterion must be met within 25 years.	All Reserve account activity will be suspended until the criterion is met.	
Structural Elements			
Project carbon in lying dead wood and standing dead wood will not actively be reduced.	Assessed during project at each verification audit*	All Reserve account activity will be suspended, unless it is demonstrated that management will provide for this structural element, or processes that produce these structural elements, over the project life.**	Applies to all project types throughout the project life
*Forest Owner must provide a policy/statement of intent with the project submission that defines the project's management of standing and lying dead wood structural elements. Overall reduction of standing dead wood is allowed in cases of imminent health, safety, disease outbreak, or as otherwise required by law which could unchecked cause a significant reversal. In the special case of a Reforestation Project following a significant disturbance that resulted in a previous project's termination, the Forest Owner must demonstrate adherence to their lying and standing dead wood policy/statement of intent at the project's initiation. Such policy/statement of intent will be verified through site inspection of recently harvested areas and general observation during site verification. ** This is intended to be an incentive to ensure the minimal standards are maintained. Decreases in inventories of lying dead and standing dead associated with a natural significant disturbance are exempt.			

3.9.3 Promotion of the Onsite Standing Live Carbon Stocks

In an effort to promote and maintain the environmental benefits of Forest Projects, the Reserve requires that the standing live carbon stocks within the Project Area are maintained and/or increased during the project life. Except as specified below, the Reserve will not issue CRTs for quantified GHG reductions and removals achieved by a Forest Project if the Forest Project's monitoring reports – over any 10-year consecutive period – indicate a decrease in the standing live carbon stocks (as defined in Section 5).

Exceptions to this policy are allowed where reductions in standing live carbon stocks are important for maintaining and enhancing forest health, environmental co-benefits, or the long-term security of all stocks, or where reductions are due to non-harvest disturbances. Note that these exceptions in no way change or affect the Reserve's policies and requirements related to compensating for reversals, as detailed in Section 7.3.

Forest Projects whose standing live carbon stocks have decreased over a 10-year period may continue to receive CRTs issued by the Reserve for verified GHG reductions and removals, if and only if the decrease in standing live carbon stocks is due to one of the following causes:

1. The decrease is demonstrably necessary to substantially improve the Project Area's resistance to wildfire, insect, or disease risks. The Forest Owner must document the risks, and the actions that will be taken to reduce the risks. The techniques used to improve resistance must be supported by relevant published peer reviewed research.
2. The decrease is associated with a planned balancing of age classes (regeneration, sub-merchantable, and merchantable) and is detailed in a long term environmentally responsible management plan. The Forest Owner must demonstrate, using documentation submitted to the Reserve at the time of the Forest Project's registration, that the balancing of age classes, resulting in a decrease in the standing live carbon stocks, was planned at the initiation of the Forest Project (**Figure 3.1**).

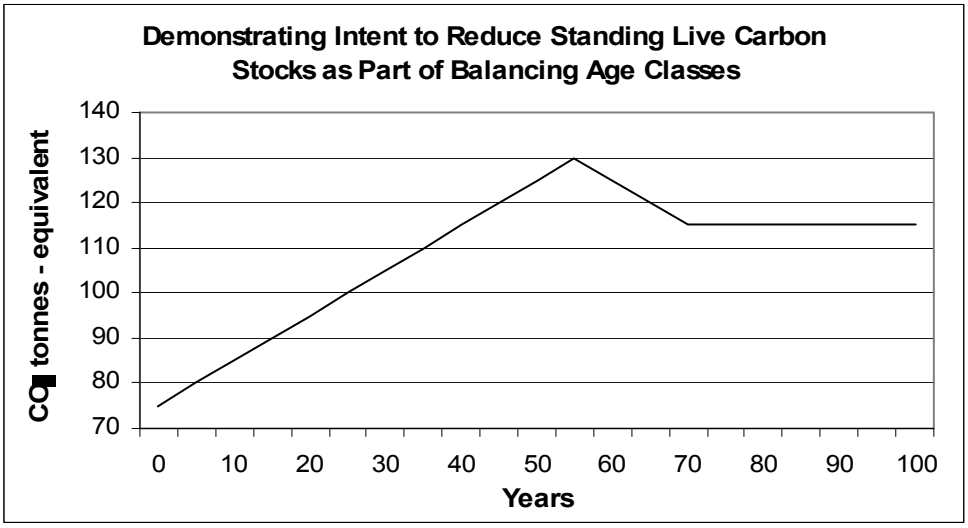


Figure 3.1. Example of Reducing Standing Live Carbon Stocks as Part of Balancing Age Classes

3. The decrease is part of normal silviculture cycles for forest ownerships less than 1,000 acres. Inventory fluctuations are a normal part of silvicultural activities. Periodic harvest may remove more biomass than the biomass growth over the past several years. At no time shall the Forest Project's inventory of carbon in the standing live carbon stocks fall below the Forest Project's baseline carbon stock estimates for the standing live carbon stocks, or 20 percent less than the Forest Project's standing live carbon stocks at the project's initiation, whichever is higher. Documentation submitted to the Reserve at the time the Forest Project is registered must indicate that fluctuations in the Forest Project's standing live carbon stocks are an anticipated silvicultural activity and that the average standing live carbon stocks are not expected to decline over successive harvests during the life of the project (Figure 3.2).

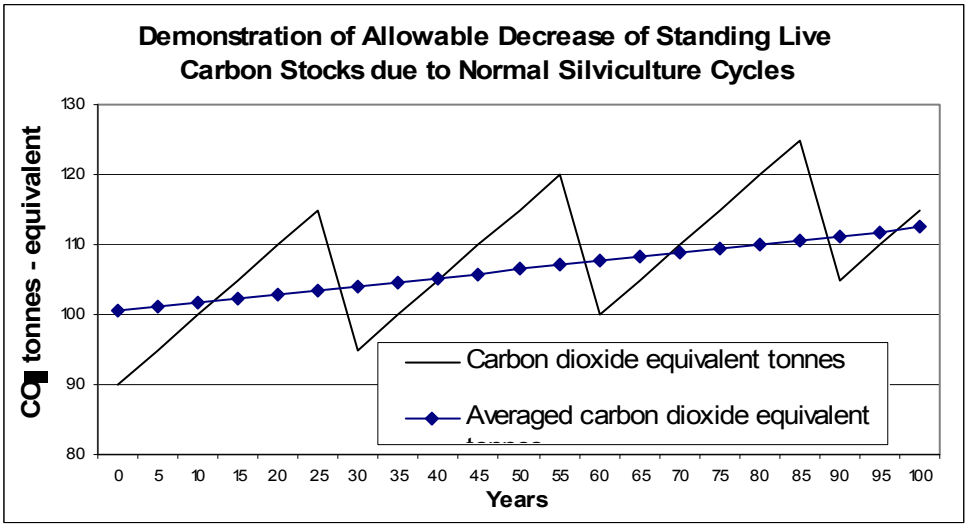


Figure 3.2. Example of Allowable Decrease of Standing Live Carbon Stocks due to Normal Silviculture Cycles

4. The decrease is part of a non-harvest disturbance, including wildfire, disease, flooding, wind-throw, insect infestation, landslides, or as otherwise approved by the Reserve.

4 Identifying the Project Area

The geographic boundaries defining the Project Area must be described in detail at the time a Forest Project is listed on the Reserve. The boundaries must be defined using a map that displays public and private roads, major watercourses, topography, towns, and public land survey Townships, Ranges, and Sections. The Project Area can be contiguous or separated into tracts.

For all Forest Project types, the geographic boundaries must not extend beyond the boundaries of an Assessment Area by more than 10 percent of the Forest Project's total area (see Appendix F for Assessment Area boundaries). A Forest Project that involves activities in multiple Assessment Areas must be submitted as separate Forest Projects (one Forest Project for each Assessment Area).

For Improved Forest Management Projects, the Project Area must include the entire project area in forest cover or forest management. Non-forest and/or non forest management areas may be removed.

For Reforestation Projects, the Project Area must be on land that has had less than 10 percent tree canopy cover for a minimum of ten years, or that have been subject to a Significant Disturbance that resulted in at least 20% of the carbon stocks being emitted.

For Avoided Conversion Projects, the Project Area is defined through the required appraisal process. The Project Area must be determined following the guidance in Table 4.1 based on the type of anticipated conversion.

Table 4.1. Project Area Definition for Avoided Conversion Projects

Conversion Type	**Project Area Definition**
Residential	The boundary of the parcel or parcels that have been appraised as described in Section 6.3 as having a 'higher and better use' in residential development.
Agricultural conversion	The area identified in the appraisal as capable of supporting the agricultural production identified as the 'higher and better use' in the appraisal.
Golf Course	The area identified as suitable for conversion to a golf course in the appraisal. This is to include forested areas within 200' of fairways, greens, and buildings.
Commercial Buildings	The area identified as suitable for commercial buildings in the appraisal. This is to include forested areas with 200' of suitable building sites.

5 Defining a Forest Project's GHG Assessment Boundary

The GHG Assessment Boundary defines all the GHG sources, sinks, and reservoirs that must be accounted for in quantifying a Forest Project's GHG reductions and removals (Section 6). The GHG Assessment Boundary encompasses all the GHG sources, sinks, and reservoirs that may be significantly affected by Forest Project activities, including forest carbon stocks, sources of biological CO_2 emissions, and mobile combustion GHG emissions. For accounting purposes, the sources, sinks, and reservoirs included in the GHG Assessment Boundary are organized according to whether they are associated with a Forest Project's "Primary Effect" (i.e. the Forest Project's intended changes in carbon stocks, GHG emissions, or GHG removals) or its "Secondary Effects" (i.e. unintended changes in carbon stocks, GHG emissions, or GHG removals caused by the Forest Project).[6] The monitoring and accounting in the FPP are based on measuring changes in carbon stocks, or the carbon reservoir. Sources and sinks are inferred from measuring changes in the reservoir.

5.1 Primary Effects

The primary, or intended, effect of a Forest Project will be a net increase in forest carbon stocks relative to the Forest Project's baseline, due to increased removals of CO_2 from the atmosphere (Reforestation and Improved Forest Management projects) or a net reduction in CO_2 emissions from harvesting, clearing, or other disturbance of Project Area carbon stocks (Improved Forest Management and Avoided Conversion Projects).

Table 5.1 lists the carbon pools (reservoirs) that must be included the GHG Assessment Boundary for Forest Projects.

Table 5.1. GHG Primary Effects – Required and Optional Reporting

GHG ASSESSMENT BOUNDARY – PRIMARY EFFECTS						
Category	**Carbon Pool**	**Type**	**Forest Management**	**Reforestation**	**Avoided Conversion**	**Determination of Value**
Living biomass	Standing Live	Reservoir	Required	Required*	Required	Sampled in Project
	Shrubs and Herbaceous Understory	Reservoir	Optional	Required	Optional	Sampled in Project
Onsite dead biomass	Standing Dead	Reservoir	Required	Required	Required	Sampled in Project
	Lying Dead Wood	Reservoir	Optional	Optional	Optional	Sampled in Project
	Litter	Reservoir	Optional	Optional	Optional	Sampled in Project
Soil	Soil**	Reservoir	Optional	Optional	Optional	Sampled in Project
Off-site dead biomass	Wood Products	Reservoir	Required	Required if harvesting operations are initiated	Required	Harvest data and decay calculation from volume of harvested wood

[6] The terms "Primary Effect" and "Secondary Effect" come from WRI/WBCSD, 2005. *The Greenhouse Gas Protocol for Project Accounting*, World Resources Institute, Washington, DC. Available at http://www.ghgprotocol.org.

* Pre-existing trees must be distinguished from planted trees. Since pre-existing and new trees are easy to distinguish for several decades after tree planting, pre-existing trees do not need to be inventoried until the Forest Owner first seeks verification of GHG reductions and removals (subsequent to the project's initial site verification and registration).
** See below

Measurement of Soil Carbon

Soil carbon is not anticipated to change significantly as a result of most Forest Project activities. However, soil carbon must be included in the GHG Assessment Boundary if either of the following activities occurs:

- Site preparation activities involve deep ripping, furrowing, or plowing where soil disturbance exceeds 25 percent of the Project Area
- Mechanical site preparation activities are not conducted on contours

5.2 Secondary Effects

Forest Projects may also have secondary, or unintended, effects on GHG emissions, including increases in CO_2 mobile emissions associated with site preparation as well as increased CO_2 emissions caused by the shifting of harvesting activities from the Project Area to other forestlands (often referred to as "leakage"). Projects are required to account for Secondary Effects following the methods described in Section 6. Table 5.2 provides a list of the categories of Secondary Effects that must be accounted for, for each type of Forest Project.

Table 5.2. GHG Secondary Effects – Required and Optional Reporting

GHG ASSESSMENT BOUNDARY – SECONDARY EFFECTS						
Category	**Description**	**Type**	**Forest Management**	**Reforestation**	**Avoided Conversion**	**Determination of Value**
Off-site Forest Biomass	Shifting harvesting or other activities to off-site forestland	Source	Required: Shift of harvest activities and/or product substitution	Required: Shift of cropland or grazing activities	Required: Shift of conversion activities	Market response and/or activity shifting analysis
Mobile Combustion Emissions	Forest management travel and logging equipment	Source	N/A	Required: Site Preparation	N/A	Calculation based on industry averages
Stationary Emissions	Forest management contractors and consulting offices	Source	N/A	N/A	N/A	Not calculated
Stationary Emissions	Production facilities of wood products	Source	N/A	N/A	N/A	Not calculated

Mobile Combustion Emissions	Transporta-tion of wood products	Source	N/A	N/A	N/A	Not calculated

6 Quantifying Net GHG Reductions and Removals

This section provides requirements and guidance for quantifying a Forest Project's net GHG reductions and removals. The Reserve will issue Climate Reserve Tonnes (CRTs) to a Forest Project upon confirmation by an approved third-party verifier that the Forest Project's GHG reductions and removals have been quantified following the applicable requirements of this section (see Section 10 for verification requirements).

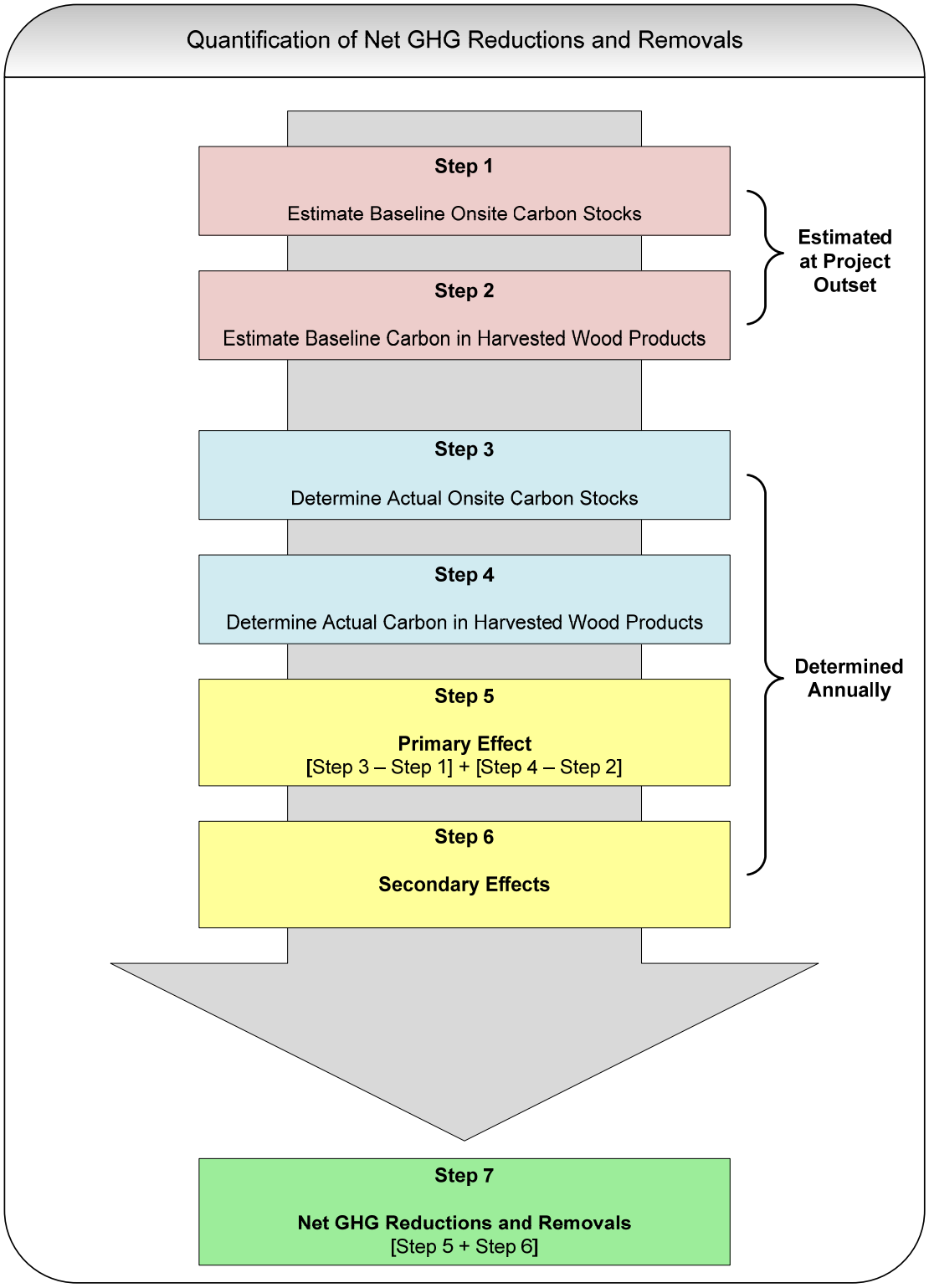
For each type of Forest Project, quantification proceeds in seven steps:

1. **Estimating baseline onsite carbon stocks.** The baseline is an estimate of what would have occurred in the absence of a Forest Project. To establish baseline onsite carbon stocks, the Forest Owner must model 100 years of carbon stock changes in each of the Forest Project's required and selected optional onsite carbon pools (identified in Section 5.1). Modeling must be based on inventoried carbon stocks at the time of the Forest Project's initiation (or when first inventoried as is allowed for Reforestation Projects), following the applicable requirements in this section. Onsite carbon stocks are inventoried following the requirements in Appendix A; modeling of onsite carbon stocks over time must be conducted following the requirements in this section and the guidance in Appendix B. Baseline onsite carbon stocks are estimated over a Forest Project's entire crediting period (100 years) at the time of the project's initiation and are not modified thereafter.
2. **Estimating baseline carbon in harvested wood products.** In conjunction with modeling baseline onsite carbon stocks, the Forest Owner must forecast any harvesting that would have occurred in the baseline and convert this to an average annual harvesting volume. From this, the Forest Owner must determine the amount of carbon that would have been transferred each year (on average) to long-term storage in wood products. Baseline harvesting is forecasted following the guidance in this section and carbon stored in wood products must be calculated following the requirements in Appendix C.
3. **Determining actual onsite carbon stocks.** Each year, the Forest Owner must determine the Forest Projects' actual onsite carbon stocks. This must be done by updating the Forest Project's forest carbon inventory for the current year, following the guidance in this section and in Appendix A and Appendix B. The estimate of actual onsite carbon stocks must be adjusted by an appropriate confidence deduction, as described in Appendix A, Section A.4.
4. **Determining actual carbon in harvested wood products.** Each year, the Forest Owner must report any harvesting in the Project Area and from this determine the amount of carbon transferred to long-term storage in wood products. Carbon stored in wood products must be calculated following the requirements in Appendix C.
5. **Calculating the project's Primary Effect.** A Forest Project's Primary Effect is the intended reduction it causes in GHG emissions, and/or its intended increase in CO_2 removals, relative to the baseline. For any given year, the Primary Effect is calculated by:
    a. Taking the difference between actual and baseline onsite carbon stocks for the current year;

   b. Subtracting from (a) the difference between actual and baseline onsite carbon stocks for the prior year;
   c. Adding to (b) the calculated difference between actual and baseline carbon in harvested wood products for the current year (see Equation 6.1).
6. **Quantifying the project's Secondary Effects.** A Forest Project's Secondary Effects are its unintended effects on GHG emissions or removals (i.e. changes in GHG emissions occurring at the sources identified in Section 5.2). Requirements and guidance for quantifying Secondary Effects are provided below for each type of Forest Project. Secondary Effects will almost always be negative (i.e. they will reflect an increase in GHG emissions caused by the project).
7. **Calculating total net GHG reductions and removals.** For each year, total net GHG reductions and removals are calculated by summing a Forest Project's Primary and Secondary Effects. If the result is positive, then the Forest Project has generated GHG reductions and/or removals in the current year. If the difference has decreased from the prior year, then a reversal has occurred (see Section 7).

Requirements and guidance for how to perform quantification steps 1-4 for each Forest Project type are presented in the remainder of this section. An example of annual GHG reduction/removal calculations for a hypothetical Forest Project is shown in Table 6.4 at the end of this section (page 39).

The required formula for quantifying annual net GHG reductions and removals is presented in Equation 6.1. Net GHG reductions and removals must be quantified and reported in units of carbon dioxide-equivalent (CO_2e) metric tonnes.


Quantification of Net GHG Reductions and Removals
Step 1
Estimate Baseline Onsite Carbon Stocks
Step 2
Estimate Baseline Carbon in Harvested Wood Products
Estimated at Project Outset
Step 3
Determine Actual Onsite Carbon Stocks
Step 4
Determine Actual Carbon in Harvested Wood Products
Step 5
Primary Effect
[Step 3 – Step 1] + [Step 4 – Step 2]
Step 6
Secondary Effects
Determined Annually
Step 7
Net GHG Reductions and Removals
[Step 5 + Step 6]

Equation 6.1.

$$QR_y = [(\Delta AC_{onsite} - \Delta BC_{onsite}) + (AC_{wp,\,y} - BC_{wp,\,y}) + SE_y] * (1 - ACD) + N_{y-1}$$

Where,

QR_y = Quantified GHG reductions and removals for year y

ΔAC_{onsite} = $(AC_{onsite,\,y})(1 - CD_y) - (AC_{onsite,\,y-1})(1 - CD_{y-1})$

Where,

$AC_{onsite,\,y}$ = Actual onsite carbon (CO_2e) as inventoried for year y

$AC_{onsite,\,y-1}$ = Actual onsite carbon (CO_2e) as inventoried for year y-1

CD_y = Appropriate confidence deduction for year y, as determined in Appendix A, Section A.4.

CD_{y-1} = Appropriate confidence deduction for year y-1, as determined in Appendix A, Section A.4.

ΔBC_{onsite} = $BC_{onsite,\,y} - BC_{onsite,\,y-1}$

Where,

$BC_{onsite,\,y}$ = Baseline onsite carbon (CO_2e) as estimated for year y

$BC_{onsite,\,y-1}$ = Baseline onsite carbon (CO_2e) as estimated for year y-1

$AC_{wp,\,y}$ = Actual carbon in wood products produced in year y that is projected to remain stored for at least 100 years, as determined in Appendix C

$BC_{wp,y}$ = Averaged annual baseline carbon in wood products that would have remained stored for at least 100 years, as determined in Appendix C

SE_y = Secondary Effect GHG emissions caused by the project activity in year y

ACD = Avoided Conversion Project discount factor, determined in Section 6.3.1.

N_{y-1} = Any negative carryover from the prior year not due to a reversal (e.g. mobile combustion emissions from site preparation for Reforestation Projects – see Section 6.1.5)

6.1 Reforestation Projects

6.1.1 Estimating Baseline Onsite Carbon Stocks

To estimate baseline carbon stocks for a Reforestation Project, the Forest Owner must:

1. Provide a qualitative characterization of baseline conditions, including an assessment of the likely vegetative conditions and activities that would have occurred, taking into consideration any laws, statutes, regulations, or other legal mandates that would encourage or require reforestation on the Project Area. The qualitative assessment shall include an assessment of the commercial value of trees within the project area over the next 30 years. The qualitative assessment must be used as the basis for modeling baseline carbon stocks (Step 3).

2. Inventory the carbon stocks in each of the project's required and selected optional carbon pools, following the requirements and guidance in Appendix A of this protocol.[7] The inventory must indicate which carbon stocks are the result of tree planting and which carbon stocks are part of the baseline. For carbon stocks that will be affected by site preparation, the inventory must be conducted prior to any site preparation activities. For other carbon stocks, the inventory may be deferred, as described below.
3. Perform a computer simulation that models the carbon stocks (from required and any selected optional pools) for 100 years, based on the qualitative characterization of baseline conditions. The Forest Owner must follow the requirements and guidance for modeling contained in Appendix B, Section B.3, incorporating any conditions and constraints specified in the qualitative characterization of the baseline (Step 1, above).

Deferral of Initial Inventory for Carbon Stocks Not Affected by Site Preparation

The inventory of carbon stocks that are not affected by site preparation may be deferred until a Reforestation Project's second site-visit verification. At the time of the second site-visit verification, the Forest Owner must provide an estimated inventory of the all required and chosen optional carbon stocks at the time of the Forest Project's start date by:

1. Assuming standing dead carbon stocks at the time of the Forest Projects' start date were equal to the standing dead carbon stocks measured and verified at the second site-visit verification.
2. Using an approved growth model or a stand table projection methodology, as described in Appendix B, Section B.1, to derive an estimate of standing live carbon stocks at the time of the Forest Project's start date. The Forest Owner must demonstrate that applying the approved growth model or stand table projection to adjusted inventory data produces a result of total carbon tonnes within 5 percent of current inventory data.

If the inventory of these carbon pools is deferred, the timing of the second site-visit verification is at the discretion of the Forest Owner (it may be deferred for more than six years). Reforestation Projects for which an initial inventory is deferred are not eligible to receive CRTs until after the second site-visit verification.

For those carbon pools that are affected by site preparation, Forest Owners shall provide an estimate of the carbon pools using the following alternatives:

1. Measuring the affected carbon pools based on 20 plots in the area within the Project Area with the greatest amount of biomass in the pool that will be affected.
2. Stratifying (Classifying) the Project Area into similar densities and measuring the affected carbon pools based on 20 plots per density class.
3. Measuring the affected based on a grid system across the Project Area.

6.1.2 Estimating Baseline Carbon in Harvested Wood Products

If harvesting of the pre-existing trees would be expected to occur in the baseline, the following steps must be performed:

1. Use a model (see guidance in Appendix B) to determine the *average* volume of harvesting in each year of the baseline over 100 years.
2. Determine the proportion of harvested wood that would be delivered to mills in each year.

[7] Initial carbon stocks could be zero if the Project Area has no quantifiable forest cover or required carbon pools.

3. From the average harvest volume delivered to mills, calculate the average amount of carbon expected to be transferred to wood products each year and stored over the long-term (100 years), following the requirements and guidance in Appendix C.

The same average annual estimate of harvested wood product carbon must be used in each year of the baseline.

6.1.3 Determining Actual Onsite Carbon Stocks

Actual carbon stocks for Reforestation Projects must be determined by updating the Project Area's forest carbon inventory. This is done by:

1. Incorporating any new forest inventory data obtained during the previous year into the inventory estimate. Any plots sampled during the previous year must be incorporated into the inventory estimate.
2. Using an approved model to "grow" (project forward) prior-year data from existing forest inventory plots to the current reporting year. Approved growth models are identified in Appendix B. Guidance for projecting forest inventory plot data using models is provided in also provided in Appendix B.
3. Updating the forest inventory estimate for harvests and/or disturbances that have occurred during the previous year.
4. Applying an appropriate confidence deduction for the inventory based on its statistical uncertainty, following the guidance in Appendix A, Section A.4.

6.1.4 Determining Actual Carbon in Harvested Wood Products

Perform the following steps to determine actual carbon in harvested wood products:

1. Determine actual harvest volumes for the current year (determined in Section 6.1.3).
2. Determine the proportion of harvested wood that was delivered to mills for the current year.
3. From the actual harvest volume delivered to mills, calculate the amount of carbon transferred to wood products and stored over the long-term (100 years), following the requirements and guidance in Appendix C.

6.1.5 Quantifying Secondary Effects

For Reforestation Projects, significant Secondary Effects can arise from two sources:

1. One-time combustion emissions associated with machinery use in site preparation; and
2. The shifting of cropland or grazing activities to forestland outside the Project Area (which may be both a market and/or physical response to the project activity), which is accounted for over the life of the project.

To quantify combustion emissions associated with site preparation, Forest Owners must use the appropriate standard emission factor from Table 6.1 corresponding to the level of brush cover on the Project Area, multiplied by the number of acres in the Project Area (Equation 6.2).

Mobile combustion emissions must be added to Secondary Effect emissions (SE_y in Equation 6.1) in the first year of a project. If this results in a negative amount for total net quantified GHG reductions and removals in year one (QR_1), the negative amount must be carried over into future years (N_{y-1} in Equation 6.1) until sufficient GHG reductions and removals are accrued to achieve a positive balance. Negative GHG reductions and removals due to site preparation emissions are *not* considered a reversal (Section 7.1).

Equation 6.2.
$MC_y = (-1) * (EF_{mc} * PA)$

Where,

MC_y = Secondary Effect CO_2e emissions due to mobile combustion from site preparation
EF_{mc} = Mobile combustion emission factor from Table 6.1
PA = The size of the Project Area, in acres

Table 6.1. Mobile Combustion Emissions for Reforestation Projects

SITE PREP - REFORESTATION PROJECTS		
Emissions Associated with Mobile Combustion		
Average Metric Tonnes CO_2e Per Acre		
Light	Medium	Heavy
25% Brush Cover	50% Dense Brush Cover	> 50% Brush Cover, stump removal
0.090	**0.202**	**0.429**

To quantify emissions from the shifting of cropland and grazing activities each year, Forest Owners must determine the appropriate "leakage" risk percentage for the project following the decision tree in
Figure 6.3. The leakage risk percentage must only be determined once, at the outset of the project. Each year, this percentage must be the net increase in onsite carbon stocks to determine the annual Secondary Effects due to shifting of cropland or grazing activities (Equation 6.3).

Equation 6.3.
$AS_y = (-1) * L * (\Delta AC_{onsite} - \Delta BC_{onsite})$

Where,

AS_y = Secondary Effect CO_2e emissions due to shifting of cropland or grazing activities
L = Leakage risk percentage, as determined from Figure 6.3
ΔAC_{onsite} = Annual difference in actual onsite carbon (CO_2e) as defined in Equation 6.1
ΔBC_{onsite} = Annual difference in baseline onsite carbon (CO_2e) as defined in Equation 6.1

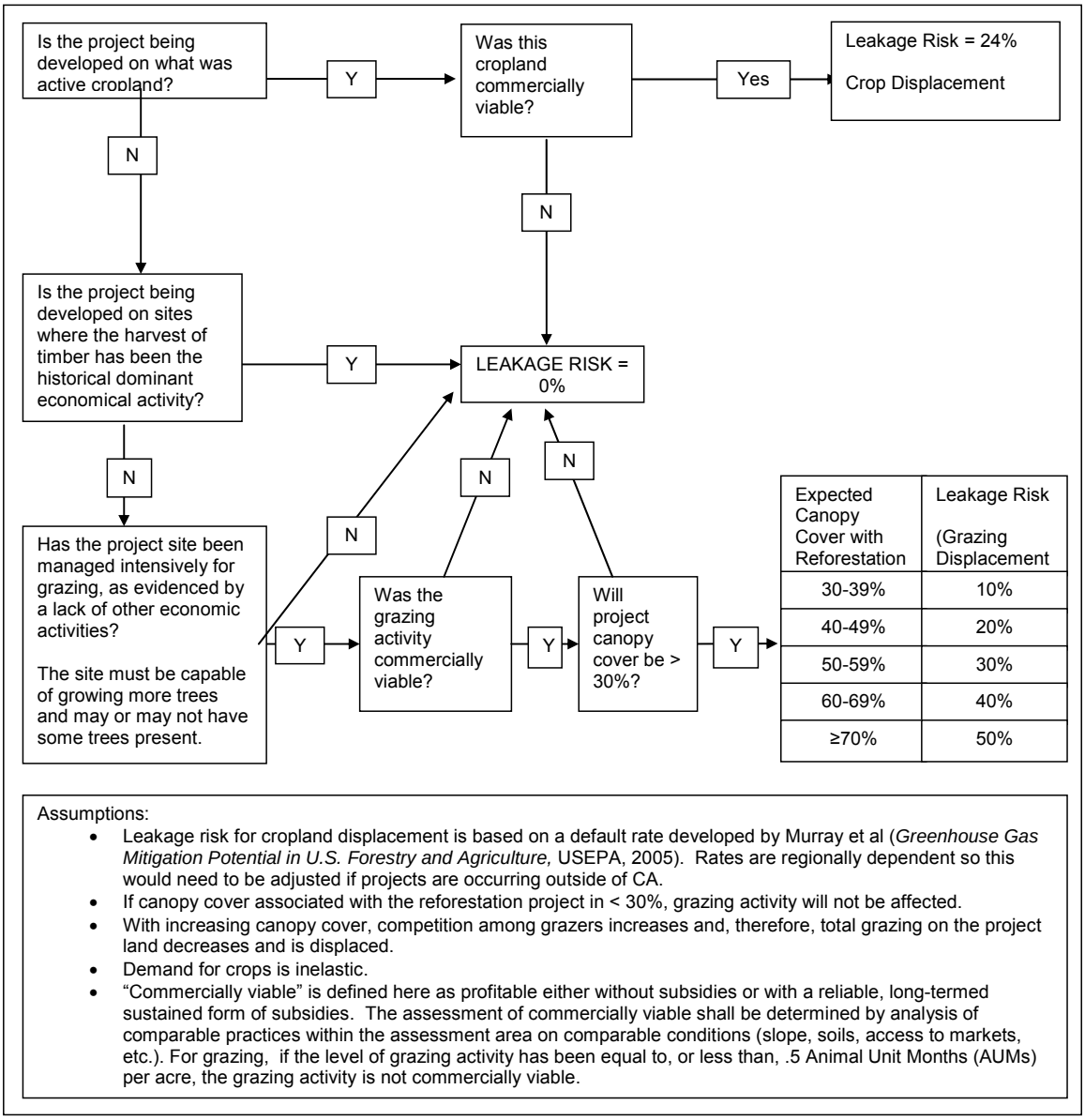


Figure 6.3. Activity Shifting ("Leakage") Risk Assessment for Reforestation Projects

Total Secondary Effect emissions for reforestation projects are calculated as follows (Equation 6.4). The value for Secondary Effect emissions will always be negative or zero.

Equation 6.4.
$\mathbf{SE_y = (AS_y + MC_y)}$ *or* **0**, whichever is lower

Where,

SE_y = Secondary Effect GHG emissions caused by the project activity in year y (Equation 6.1)
AS_y = Secondary Effect CO_2e emissions due to shifting of cropland or grazing activities
MC_y = Secondary Effect CO_2e emissions due to mobile combustion from site preparation*
*only occurs in year 1.

6.2 Improved Forest Management Projects

For Improved Forest Management Projects, the requirements and procedures for estimating baseline onsite carbon stocks differ depending on whether the project takes place on private or public land. Requirements for determining baseline carbon in harvested wood products, determining actual onsite carbon stocks, determining actual carbon in harvested wood products, and quantifying Secondary Effects are the same for all Improved Forest Management Projects.

6.2.1 Estimating Baseline Onsite Carbon Stocks – Private Lands

The baseline approach for Improved Forest Management Projects on private lands applies a standardized set of assumptions to project-specific conditions. A key assumption is that baseline carbon stocks will depend on how a project's initial standing live carbon stocks compare to "Common Practice," defined as the average standing live carbon stocks on similar lands within the project's Assessment Area. In addition, the baseline must be modeled to reflect all legal and economic constraints.

The following steps must be followed to estimate baseline carbon stocks:

1. Look up the Common Practice level of standing live carbon stocks for the project's Assessment Area.
2. Determine if the Project Area's initial standing live carbon stocks are above or below Common Practice.
3. Estimate baseline carbon stocks, taking into account financial and legal constraints on harvesting in the Project Area. In addition:
    a. If initial standing live carbon stocks are above Common Practice, the baseline for standing live carbon stocks must not fall below Common Practice.
    b. If initial standing live carbon stocks are below Common Practice, the baseline for standing live carbon stocks must not fall below historical levels for the Project Area.
4. Determine the baseline carbon stocks over 100 years for all required and optional carbon pools in the Project Area.

Step 1 – Look up the Common Practice Carbon Stocks for the Project's Assessment Area

As defined in this protocol, Common Practice refers to the average stocks of standing live carbon stocks within a project's Assessment Area. Common Practice is used as a reference point for baseline estimation. The Reserve has calculated, or is in the process of calculating, Common Practice carbon stock estimates for FIA Assessment Areas throughout the United States. Appendix F provides maps of the Assessment Areas in California, along with a lookup table for Common Practice carbon stock levels in those Assessment Areas. Maps and Common Practice carbon stock levels for Assessment Areas in other states will be made available on the Reserve's website.

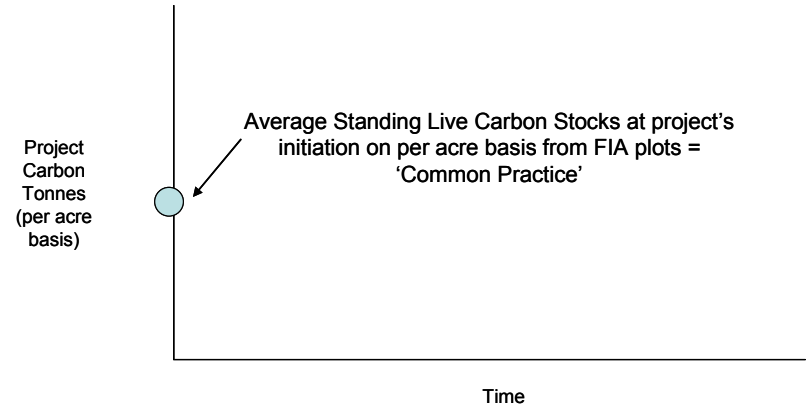


Figure 6.4. Common Practice as a Reference Point for Baseline Estimation

Step 2 – Determine if Initial Standing Live Carbon Stocks Are Above or Below Common Practice

To determine if initial standing live carbon stocks are above or below Common Practice, perform the following steps:

1. From the initial forest carbon inventory for the Project Area (conducted following the requirements and guidance in Appendix A), identify the metric tonnes of carbon associated with the standing live carbon stocks.
2. Divide this amount by the number of acres in the Project Area.
3. Compare the result with the Common Practice standing live carbon stocks per acre identified in Step 1.

Step 3 – Determine Baseline Standing Live Carbon Stocks

If project standing live carbon stocks are above Common Practice, proceed with modeling the baseline following the requirements of Step 3a.

If project standing live carbon stocks are below Common Practice, proceed with modeling the baseline following the requirements of Step 3b.

Step 3a – Determining Baseline Standing Live Carbon Stocks Where Initial Stocks Are Above Common Practice

Determining the standing live carbon stocks baseline involves two steps:

1. Model standing live carbon stocks through a series of growth and harvesting scenarios over 100 years. The modeling must be performed following the guidance in Appendix B and must meet the following conditions:
    a. Growth and harvesting scenarios must reflect all legal constraints, following the requirements in Section 6.2.1.1 (below).
    b. Growth and harvesting scenarios must reflect any financial constraints, following the requirements in Section 6.2.1.2 (below).

    A graphical example of a baseline meeting these conditions is provided in Figure 6.5.
2. Average the model results over the 100-year timeframe, so that the baseline contains the same (average) value for carbon stocks in every year. The averaged model results must not be below Common Practice (see example in Figure 6.6).

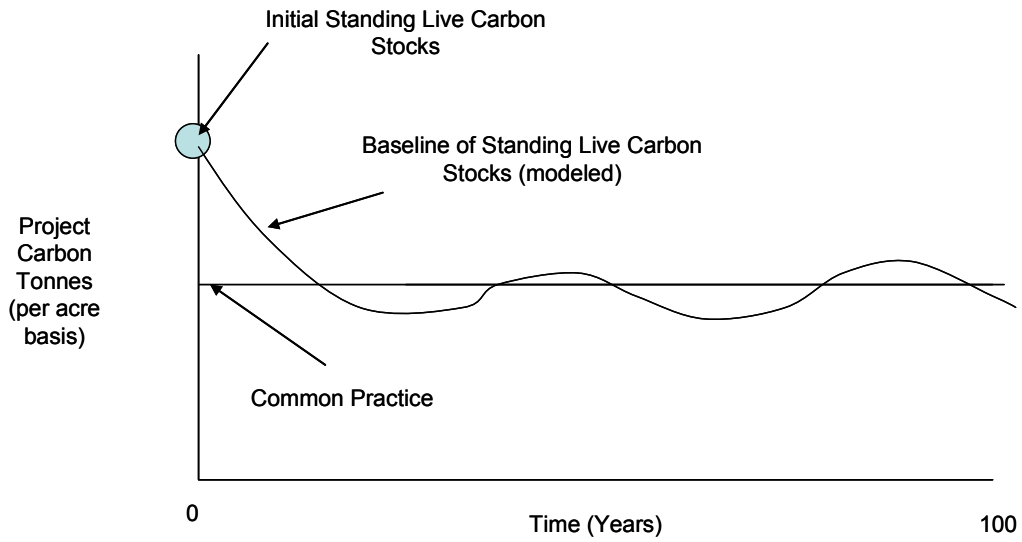


Figure 6.5. Modeling Standing Live Carbon Stocks Where Initial Stocks Are Above Common Practice

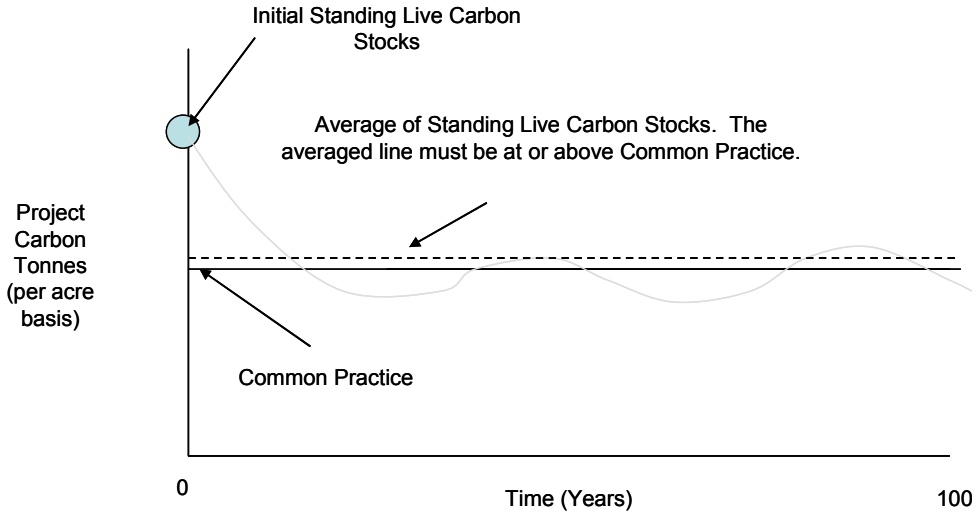


Figure 6.6. Averaging the Modeled Standing Live Carbon Stocks Where Initial Stocks Are Above Common Practice

Step 3b – Determining Baseline Standing Live Carbon Stocks Where Initial Stocks Are Below Common Practice

Determining the standing live carbon stock baseline involves three steps:

1. Determine the "High Stocking Reference" for the Project Area. The High Stocking Reference is defined as 80 percent of the highest carbon stocks in live trees during the preceding 10-year period. To determine the High Stocking Reference, the Forest Owner must document changes in the Project Area's live-tree carbon stocks over the preceding 10 years, or as long as the Forest Owner has had control of the stocks. Figure 6.7 presents an example of how the High Stocking Reference is determined.

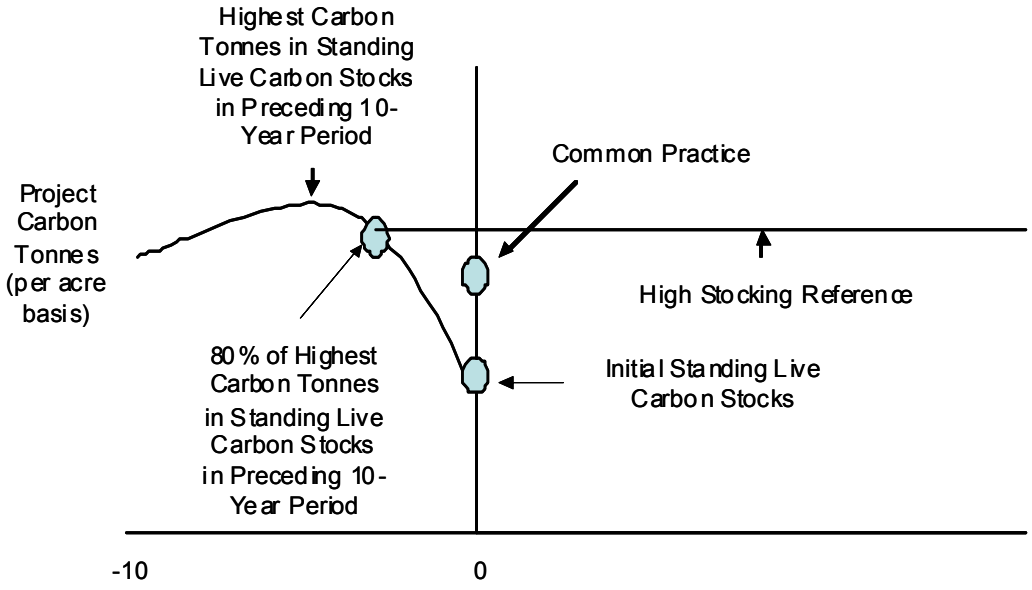


Figure 6.7. Determining a Project Area's High Stocking Reference
* It is possible for the High Stocking Reference to be higher than Common Practice, even where initial live-tree carbon stocks for the project are below Common Practice.

2. Model standing live carbon stocks through a series of growth and harvesting scenarios over 100 years. The modeling must be performed following the guidance in Appendix B and must meet the following conditions:
    a. Growth and harvesting scenarios must reflect all legal constraints, following the requirements in Section 6.2.1.1 (below).
    b. Growth and harvesting scenarios must reflect any financial constraints, following the requirements in Section 6.2.1.2 (below).
    c. The average standing live carbon stock levels per acre associated with the growth and harvesting scenarios must not fall below the initial standing live carbon stocks for the Project Area or the High Stocking Reference, whichever is higher.

    A graphical example of a baseline meeting these conditions is provided in Figure 6.8.
3. Average the model results over the 100-year timeframe, so that the baseline contains the same (average) value for carbon stocks in every year. The averaged model results must not be below the initial standing live carbon stocks for the Project Area or the High Stocking Reference, whichever is higher (see example in Figure 6.9).

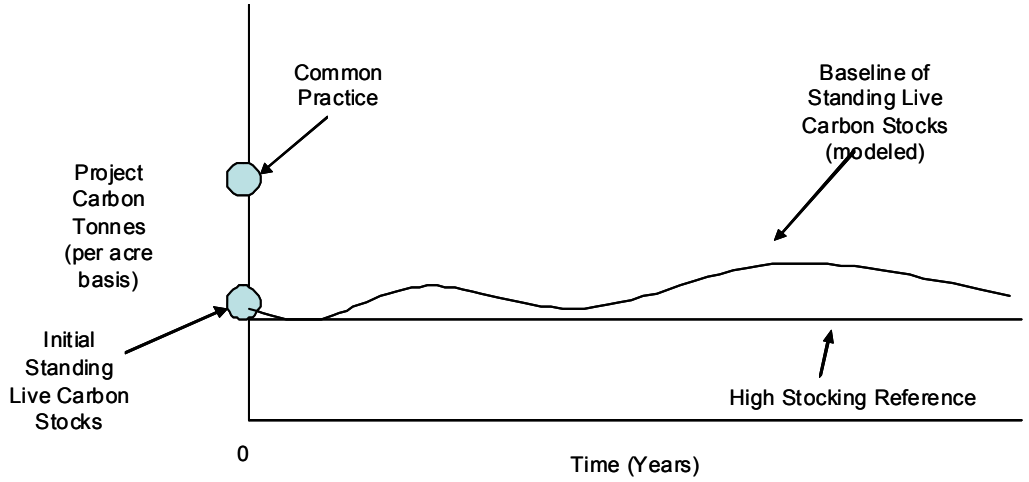


Figure 6.8. Modeling Standing Live Carbon Stocks Where Initial Stocks Are Below Common Practice

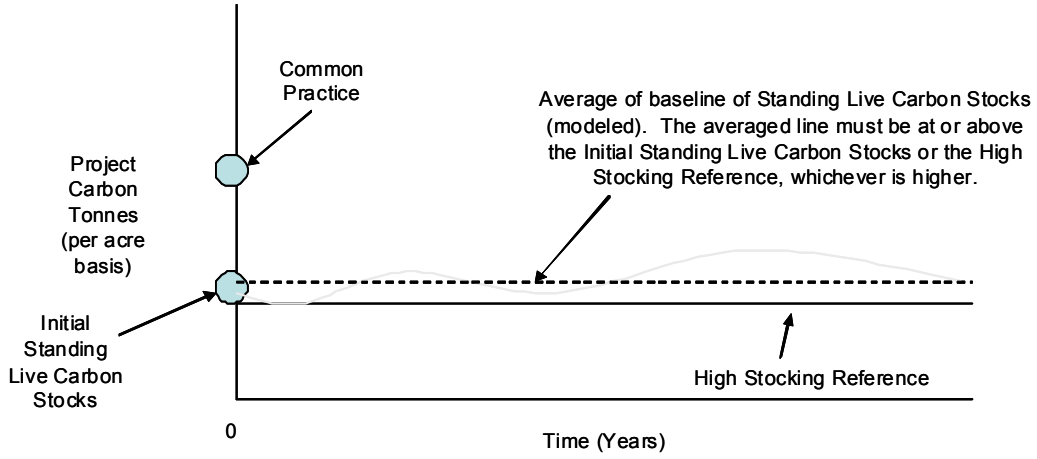


Figure 6.9. Averaging the Modeled Standing Live Carbon Stocks Where Initial Stocks Are Below Common Practice

Step 4 – Determine the Baseline for All Carbon Pools

Once the baseline for standing live carbon stocks has been determined, perform the following steps:

1. Estimate baseline carbon stocks for all other required and optional carbon pools identified for the project (such as standing and lying dead carbon stocks). These carbon stocks must be modeled or estimated following the requirements and guidance in Appendix A and Appendix B.
2. Average the results, so that the baseline for other carbon pools contains the same (average) value for carbon stocks in every year.
3. Sum the standing live carbon stock baseline and the baseline for all other carbon stocks to produce a final baseline for all carbon pools (see Figure 6.10).

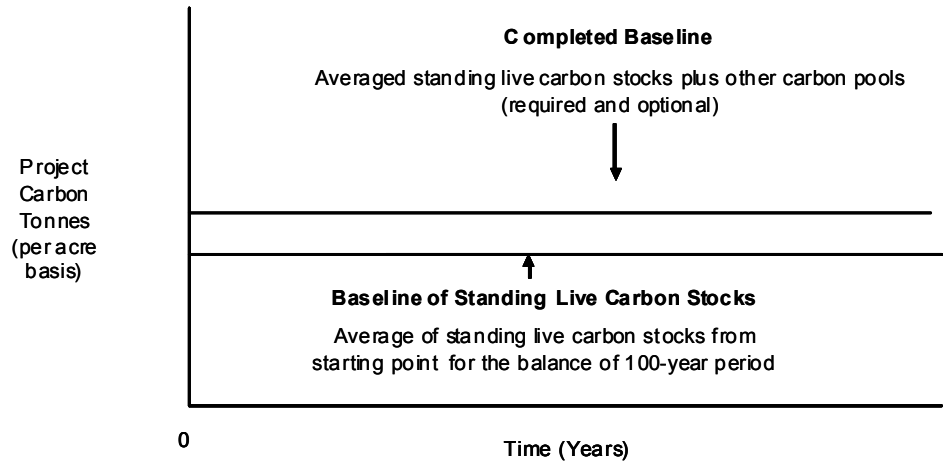


Figure 6.10. Final Baseline Incorporating All Required and Optional Carbon Stocks

6.2.1.1 Consideration of Legal Constraints

In modeling the baseline for standing live carbon stocks, the Forest Owner must incorporate all legal requirements that could affect baseline growth and harvesting scenarios. The standing live carbon stock baseline must represent a growth and harvesting regime that fulfills all legal requirements. Voluntary agreements that can be rescinded, such as voluntary Habitat Conservation Plans (HCPs), Safe Harbor Agreements, rental contracts, and forest certification, are not legal requirements,

Legal requirements include all laws, regulations, and legally-binding commitments applicable to the Project Area at the time of the project's initiation that could affect standing live carbon stocks. Legal constraints include:

1. Federal, state/provincial, or local government regulations that are required and might reasonably be anticipated to influence carbon stocking over time including, but not limited to:
    a. Zones with harvest restrictions (e.g. buffers, streamside protection zones, wildlife protection zones),
    b. Harvest adjacency restrictions, and
    c. Minimum stocking standards.
2. Forest practice rules, or applicable Best Management Practices established by federal, state, provincial or local government that relate to forest management.
3. Other legally binding requirements affecting carbon stocks including, but not limited to, covenants, conditions and restrictions, and other title restrictions in place prior to or at the time of project initiation, including pre-existing conservation easements and deed restrictions, excepting an encumbrance that was put in place and/or recorded less than one year prior to the project start date, as defined in Section 3.6.

6.2.1.2 Consideration of Financial Constraints

In modeling the baseline for standing live carbon stocks, the Forest Owner must incorporate financial constraints that could affect baseline growth and harvesting scenarios. The Forest Owner must demonstrate that the growth and harvesting regime assumed for the baseline is financially feasible through one of the following means:

1. A financial analysis of the anticipated growth and harvesting regime that captures all relevant costs and returns, taking into consideration all legal, physical, and biological constraints. Cost and revenue variables in the financial analysis may be based on regional norms or on documented costs and returns for the Project Area or other properties in the project's Assessment Area.
2. Providing evidence that activities similar to the proposed baseline growth and harvesting regime have taken place on other properties within the Forest Project's Assessment Area within the past 15 years. The evidence must demonstrate that harvesting activities have taken place on at least one other comparable site with:
    a. Slopes that do not exceed slopes in the Project Area by more than 10 percent
    b. An equivalent zoning class to the Project Area
    c. Comparable species composition to the Project Area (i.e. within 20% of project species composition based on trees per acre)
    d. Similar access by road, cable, or helicopter

6.2.2 Estimating Baseline Onsite Carbon Stocks – Public Lands

For Improved Forest Management Projects on lands owned or controlled by public agencies, the baseline must be estimated by:

1. Conducting an initial forest carbon inventory for the Project Area.
2. Projecting future changes to Project Area forest carbon stocks by:
    a. Extrapolating from historical trends; and
    b. Anticipating how current and future public policy will affect onsite carbon stocks.

The method that results in the highest estimated carbon stock levels must be used to determine the baseline.

To extrapolate from historical trends:

- For Project Areas that have a ten-year history of declining carbon stocks, the baseline must be defined by the average of the carbon stocks over the past ten years and considered static for the project life (i.e. the same level of carbon stocks is assumed in every year).
- For Project Areas that demonstrate an increasing inventory of carbon stocks over the past ten years, the growth trajectory of the baseline shall continue until the forest achieves a stand composition consistent with comparable forested areas that have been relatively free of harvest over the past 60 years. This is intended to include the effects of disturbance elements that have affected the forest condition.

To anticipate how current and future public policy will affect onsite carbon stocks, the baseline must be modeled following the guidance in Appendix B incorporating constraints imposed by all applicable statutes, regulations, policies, plans and Activity-Based Funding.

6.2.3 Estimating Baseline Carbon in Harvested Wood Products

To estimate the amount of baseline carbon transferred to long-term storage in wood products each year, the following steps must be performed:

1. Determine the *average* volume of harvesting in each year of the baseline over 100 years.
    a. For projects on private lands, the volume of harvesting must be derived from the growth and harvesting regime used to develop the baseline for onsite carbon stocks in Section 6.2.1.

   b. For projects on public lands, the volume of harvesting must be derived from the growth and harvesting regime assumed in the baseline for onsite carbon stocks derived in Section 6.2.2.
2. Determine the proportion of harvested wood that would be delivered to mills in each year.
3. From the average harvest volume delivered to mills, calculate the average amount of carbon expected to be transferred to wood products each year and stored over the long-term (100 years), following the requirements and guidance in Appendix C.

The same average annual estimate of harvested wood product carbon must be used in each year of the baseline.

6.2.4 Determining Actual Onsite Carbon Stocks

Actual carbon stocks for Improved Forest Management projects must be determined by updating the Project Area's forest carbon inventory. This is done by:

1. Incorporating any new forest inventory data obtained during the previous year into the inventory estimate. Any plots sampled during the previous year must be incorporated into the inventory estimate.
2. Using an approved model to "grow" (project forward) prior-year data from existing forest inventory plots to the current reporting year. Approved growth models are identified in Appendix B. Guidance for projecting forest inventory plot data using models is also provided in Appendix B.
3. Updating the forest inventory estimate for harvests and/or disturbances that have occurred during the previous year.
4. Applying an appropriate confidence deduction for the inventory based on its statistical uncertainty, following the guidance in Appendix A, Section A.4.

6.2.5 Determining Actual Carbon in Harvested Wood Products

Perform the following steps to determine actual carbon in harvested wood products:

1. Determine actual harvest volumes for the current year (determined in Section 6.2.4).
2. Determine the proportion of harvested wood that was delivered to mills for the current year.
3. From the actual harvest volume delivered to mills, calculate the amount of carbon transferred to wood products and stored over the long-term (100 years), following the requirements and guidance in Appendix C.

6.2.6 Quantifying Secondary Effects

For Improved Forest Management Projects, significant Secondary Effects can occur if a project reduces harvesting in the Project Area, resulting in an increase in harvesting on other properties. Substitution effects, such as a project causing consumers to shift consumption to alternative building materials, which may have higher associated GHG emissions than wood products, are not quantified in this protocol since it is assumed the emitting sectors affected by the shift in consumption will be capped in a compliance program.

The following steps must be performed to quantify Secondary Effects for Improved Forest Management Projects:

1. Estimate the total projected volume of harvested wood products that will be produced over 100 years under the project, and convert this volume to metric tonnes of CO_2-equivalent.

2. Estimate the total volume of harvested wood products that would have been produced over 100 years in the baseline (as determined in Section 6.2.3), and convert this volume to metric tonnes of CO_2-equivalent.
3. Subtract the result in (1) from the result in (2).
4. If the result in (3) is greater than zero (i.e. baseline harvesting is greater than project harvesting under the project), then multiply by 20% to derive the total Secondary Effects of the project over 100 years (Equation 6.5). If the result in (3) is less than zero, then Secondary Effects for the project are assumed to be zero.
5. Calculate SE_y using Equation 6.6. This is the assumed annual Secondary Effect estimate to be used for every year of the project (used in Equation 6.1).

Equation 6.5.
If $(\sum HWP_{baseline} - \sum HWP_{project}) > 0$, **then** $SE_{100\text{-}year} = 20\% * (\sum HWP_{baseline} - \sum HWP_{project\ activity})$,
else $SE_{100\text{-}year} = 0$

Equation 6.6.
$$\mathbf{SE_y = (-1) * (SE_{100\text{-}year} / 100\ years)}$$

Where,

$HWP_{baseline}$ = Expected harvesting volume expressed in CO_2-equivalent tonnes for each year of the baseline.

$HWP_{project}$ = Expected harvesting volume expressed in CO_2-equivalent tonnes for each year of the project.

$SE_{100\text{-}year}$ = Estimated total Secondary Effects over the 100-year project period.

SE_y = Estimated annual Secondary Effects (used in Equation 6.1).

6.3 Avoided Conversion Projects

6.3.1 Estimating Baseline Onsite Carbon Stocks

The baseline for Avoided Conversion projects is a projection of onsite forest carbon stock losses that would have occurred over time due to the conversion of the Project Area to a non-forest land use. Estimating the baseline for Avoided Conversion Projects involves two steps:

1. Characterizing and projecting the baseline
2. Discount for the uncertainty of conversion probability

Step 1 - Characterizing and Projecting the Baseline

Forest Owners must characterize and project the baseline by:

1. Clearly specifying an alternative highest-value land use for the Project Area, as identified by an appraisal (required in Section 3.1.2.3).
2. Estimating the rate of conversion and removal of onsite carbon stocks.
3. Using a computer simulation to project changes in onsite carbon stocks over 100 years, reflecting the rate of conversion estimated in (2). The simulation must model changes in onsite carbon stocks for all required and selected optional carbon pools, as identified in Section 5.1.

The rate of conversion and removal of onsite carbon stocks must be estimated by either:

1. Referencing planning documentation for the Project Area (e.g. construction documents or plans) that specifies the timeframe of the conversion and intended removal of forest cover on the Project Area; or
2. In the absence of specific documentation, identifying a default annual conversion rate from Table 6.2.

Table 6.2. Default Avoided Conversion Rates

Type of Conversion Identified in Appraisal	**Total Conversion Impact** This is the assumed total effect over time of the conversion activity. (The total conversion impact is amortized over a 10-year period to determine the annual rate of conversion in the next column.)	**Annual Rate of Conversion** This is the assumed annual rate of the conversion activity. The percentages below are multiplied by the initial onsite carbon stocks for the project on an annual basis for the first 10 years of the project.
Residential	Estimate using the following formula: TC = 3 / A *Where:* TC = % total conversion (TC cannot exceed 100%) A = the parcel sizes identified in the appraisal	Estimate using the following formula: ARC = TC / 10 *Where:* ARC = % annual rate of conversion TC = % total conversion
Mining and agricultural conversion, including pasture or crops	90%	9.0%
Golf course	80%	8.0%
Commercial buildings	95%	9.5%

The computer simulation of the baseline must apply the identified rate of conversion over time to estimate changes in onsite carbon stocks, beginning with the Project Area's initial onsite carbon stocks.

If the projected conversion rate does not result in a complete removal of onsite forest carbon stocks, the baseline projection should account for any residual forest carbon value as a steady condition for the balance of a 100-year projection. See Figure 6.11 for an example of a projected baseline for a hypothetical project that avoids residential conversion, using an appropriate conversion rate from Table 6.2.

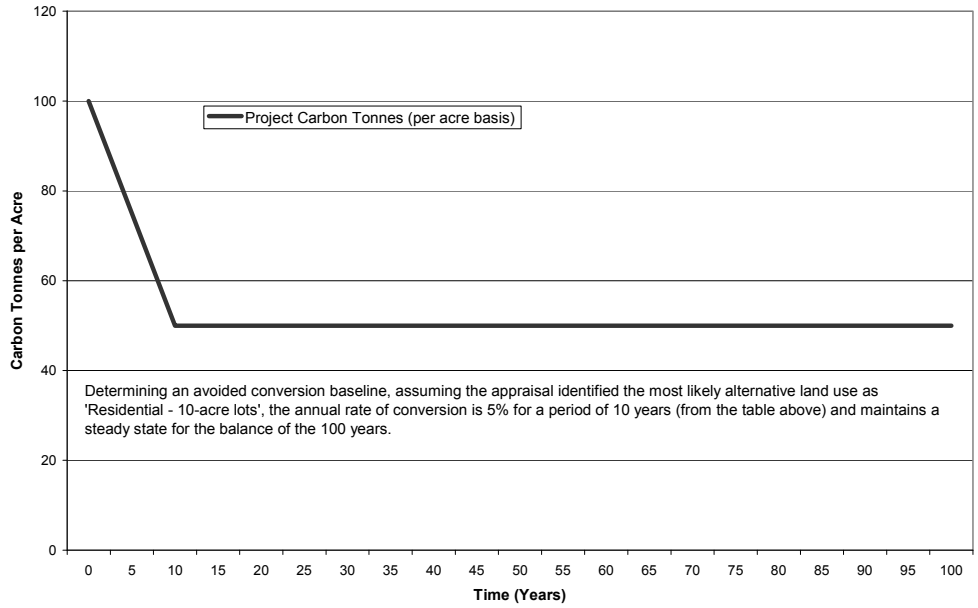


Figure 6.11. Example of a Project Avoided Conversion Project Baseline

Step 2 - Discount for Uncertainty of Conversion Probability

If the fair market value of the anticipated alternative land use for the Project Area (as determined by the appraisal required in Section 3.1.2.3) is *not more than 80 percent greater* than the value of the current forested land use, then a discount must be applied each year to the project's quantified GHG reductions. Use the following formula (Equation 6.7) to calculate the appropriate discount factor, ACD.

Equation 6.7.

ACD = **If** 0.4 < ((VA / VP) – 1) < 0.8, **then** [80% – ((VA / VP) – 1)] * 2.5
If ((VA / VP) – 1) > 0.8, **then** 0%
If ((VA / VP) – 1) < 0.4, **then** 100%

Where,

ACD = The Avoided Conversion Project discount factor (used in Equation 6.1).

VA = The appraised fair market value of the anticipated alternative land use for the Project Area

VP = The appraised fair market value of the current forested land use for the Project Area

6.3.2 Estimating Baseline Carbon in Harvested Wood Products

Harvesting is assumed to occur in the baseline over time as the Project Area is converted to another land use. To estimate the baseline carbon transferred to long-term storage in harvested wood products each year:

1. Determine the volume of harvesting consistent with the reduction in baseline onsite carbon stocks for the current year, as determined in Section 6.3.1.
2. Determine the proportion of harvested wood that would be delivered to mills in each year.
3. From the average harvest volume delivered to mills, calculate the average amount of carbon expected to be transferred to wood products each year and stored over the long-term (100 years), following the requirements and guidance in Appendix C.

6.3.3 Determining Actual Onsite Carbon Stocks

Actual carbon stocks for Avoided Conversion Projects must be determined by updating the Project Area's forest carbon inventory. This is done by:

1. Incorporating any new forest inventory data obtained during the previous year into the inventory estimate. Any plots sampled during the previous year must be incorporated into the inventory estimate.
2. Using an approved model to "grow" (project forward) prior-year data from existing forest inventory plots to the current reporting year. Approved growth models are identified in Appendix B. Guidance for projecting forest inventory plot data using models is also provided in Appendix B.
3. Updating the forest inventory estimate for harvests and/or disturbances that have occurred during the previous year.
4. Applying an appropriate confidence deduction for the inventory based on its statistical uncertainty, following the guidance in Appendix A, Section A.4.

6.3.4 Determining Actual Carbon in Harvested Wood Products

Perform the following steps to determine actual carbon in harvested wood products:

1. Determine actual harvest volumes for the current year (determined in Section 6.3.3).
2. Determine the proportion of harvested wood that was delivered to mills for the current year.
3. From the actual harvest volume delivered to mills, calculate the amount of carbon transferred to wood products and stored over the long-term (100 years), following the requirements and guidance in Appendix C.

6.3.5 Quantifying Secondary Effects

Significant Secondary Effects for Avoided Conversion projects can arise if the type of land use conversion that would have happened on the Project Area is shifted to other forest land.

To quantify Secondary Effects for Avoided Conversion projects, Forest Owners must:

1. Consult Table 6.3 to determine the "conversion displacement risk" applicable to the region or state where the project is located.
2. Quantify Secondary Effect emissions using Equation 6.8. The value for Secondary Effect emissions will always be negative or zero.

Table 6.3. Conversion Displacement Risk Values by Region/State

Region/State	Basis	Source	Conversion Displacement Risk
California	Maximum forestland conversion rate by	CalFire Fire and Resource Assessment Program	3.6%

	county. The maximum value was chosen as a conservative estimate of Secondary Effects.[8]	(FRAP)	

Equation 6.8.
SEy = (-1) * CDR * (Δ AConsite - Δ BConsite) or **0**, whichever is lower

Where,

SE_y = Secondary Effect GHG emissions caused by the project activity in year y (Equation 6.1)
CDR = Conversion displacement risk value, as determined from Table 6.3
ΔAC_{onsite} = Annual difference in actual onsite carbon (CO_2e) as defined in Equation 6.1
ΔBC_{onsite} = Annual difference in baseline onsite carbon (CO_2e) as defined in Equation 6.1

Table 6.4. Example of Annual GHG Reduction/Removal Calculations
[TO BE INSERTED]

7 Ensuring the Permanence of Credited GHG Reductions and Removals

The Reserve requires that credited GHG reductions and removals be effectively "permanent." For Forest Projects, this requirement is met by ensuring that the carbon associated with credited GHG reductions and removals remains stored for at least 100 years.

The Reserve ensures the permanence of GHG reductions and removals through three mechanisms:

1. The requirement for all Forest Owners to monitor onsite carbon stocks, submit annual monitoring reports, and submit to annual third-party verification of those reports along with periodic verifier site visits (as detailed in Sections 8 through 10 of this protocol) for the duration of the Project Life.
2. The requirement for all Forest Owners to sign a Project Implementation Agreement with the Reserve, as described in Section 3.5, which obligates Forest Owners to retire CRTs to compensate for reversals of GHG reductions and removals.
3. The maintenance of a Buffer Pool to provide insurance against reversals of GHG reductions and removals due to unavoidable causes (including natural disturbances such a fires, pest infestations, or disease outbreaks).

GHG reductions and removals can be "reversed" if the stored carbon associated with them is released (back) to the atmosphere. Many biological and non-biological agents, both natural and human-induced, can cause reversals. Some of these agents cannot completely be controlled (and are therefore "unavoidable"), such as natural agents like fire, insects, and wind. Other agents can be controlled, such as the human activities like land conversion and over-harvesting.

[8] The maximum conversion rate in the state is 1.8%. This rate reflects the conversion rate across all forestlands, regardless of consideration of attributes that place certain lands at a higher risk of conversion than others. Assuming that 50% of forested landscapes are available for conversion, the 1.8% is doubled for a defined Secondary Effects risk of 3.6%.

Under this protocol, reversals due to controllable agents are considered "avoidable." As described in this section, Forest Owners are required to identify and quantify the risk of reversals from different agents based on project-specific circumstances. The resulting risk rating determines the quantity of Climate Reserve Tonnes (CRTs) that the project must contribute to the Reserve Buffer Pool to insure against reversals.

7.1 Definition of a Reversal

Project owners must demonstrate, through annual reporting and periodic site verification, that stocks associated with credited GHG reductions and removals are maintained for a period of time considered to be permanent (i.e. 100 years). If the difference between project and baseline onsite carbon stocks decreases from one year to the next (i.e. if $\Delta\ AC_{onsite} - \Delta\ BC_{onsite}$ in Equation 6.1 is negative) the Reserve will consider this to be a reversal, regardless of the cause of the decrease. Planned thinning or harvesting activities, for example, may cause a reversal if they result in a negative value for $\Delta\ AC_{onsite} - \Delta\ BC_{onsite}$.

7.2 Insuring Against Reversals

The Reserve requires Forest Owners to insure against reversals, based on a project-specific risk evaluation. Currently, insurance must take the form of contributing CRTs to the Buffer Pool administered by the Reserve. In the future, the Reserve anticipates that other insurance instruments may be available to insure against reversals.

7.2.1 About the Buffer Pool

The Buffer Pool is a holding account for Forest Project CRTs, which is administered by the Reserve. All Forest Projects must contribute a percentage of CRTs to the Buffer Pool any time they are issued CRTs for verified GHG reductions and removals. Each Forest Project's contribution is determined by a project-specific risk rating, as described in Section 7.2.2. If a Forest Project experiences an unavoidable reversal of GHG reductions and removals (as defined in Section 7.3), the Reserve will retire a number of CRTs from the Buffer Pool equal to the total amount of carbon that was reversed (measured in metric tonnes of CO_2-equivalent). The Buffer Pool therefore acts as a general insurance mechanism against unavoidable reversals for all Forest Projects registered with the Reserve.

7.2.2 Contributions to the Buffer Pool

Each time the Reserve issues CRTs for verified GHG reductions and removals achieved by a Forest Project, a certain percentage of those CRTs must be contributed to the Buffer Pool. The size of the contribution to the Buffer Pool will depend on the Forest Project's risk rating for reversals. For example, if a Forest Project is issued 10 CRTs after annual verification, and the project's reversal risk rating is 10 percent, then 9 CRTs will be issued to the Forest Owner's Reserve account and 1 CRT must be deposited in the Buffer Pool.

Forest Owners must determine the reversal risk rating for a project by following the requirements and guidance in Appendix D. The risk rating must be determined prior to registration, and recalculated in every year the project undergoes a verification site visit (see Section 10.2).

Forest Owners who record a conservation easement or deed restriction in conjunction with implementing a Forest Project will receive a lower risk rating (see Appendix D).

Forest Owners may be able to reduce the risk rating through actions that lower the risk profile of their project. If a Forest Project's risk rating declines, the Reserve may distribute previously withheld Buffer Pool CRTs to the Forest Owner in proportion to the reduced risk.

7.2.3 Other Insurance Options for Reversals

It is the Reserve's expectation that other options to insure against reversals will develop for projects in the future. These options may include direct insurance. Alternative insurance mechanisms could be used to directly reduce the required Buffer Pool contributions for a project. The Reserve must review and approve alternative insurance mechanisms before they may be used.

7.3 Compensating for Reversals

The Reserve requires that all reversals be compensated through the retirement of CRTs. If a reversal associated with a Forest Project was unavoidable (as defined below), then the Reserve will compensate for the reversal on the Forest Owner's behalf by retiring CRTs from the Buffer Pool. If a reversal was avoidable (as defined below), then the Forest Owner must compensate for the reversal by surrendering CRTs from its Reserve account.

7.3.1 Unavoidable Reversals

An Unavoidable Reversal is any reversal not due to the Forest Owner's negligence, gross negligence or willful intent, including wildfires or disease that are not the result of the Forest Owner's negligence, gross negligence or willful intent. Requirements for Unavoidable Reversals are as follows:

1. If the Forest Owner determines there has been an Unavoidable Reversal, it must notify the Reserve in writing of the Unavoidable Reversal within six months of its occurrence.
2. The Forest Owner must explain the nature of the Unavoidable Reversal and provide a verified estimate of onsite carbon stocks within one year so that the reversal can be quantified (in units of CO_2-equivalent metric tonnes).

If the Reserve determines that there has been an Unavoidable Reversal, it will retire a quantity of CRTs from the Buffer Pool equal to size of the reversal in CO_2-equivalent metric tonnes.

7.3.2 Avoidable Reversals

An Avoidable Reversal is any reversal that is due to the Forest Owner's negligence, gross negligence, or willful intent, including harvesting, development, and harm to the Project Area due to the Forest Owner's negligence, gross-negligence or willful intent. Requirements for Avoidable Reversals are as follows:

1. If the Forest Owner determines that an Avoidable Reversal has occurred, it must give written notice to the Reserve within thirty days. Additionally, if the Reserve determines that an Avoidable Reversal has occurred, it shall deliver written notice to the Forest Owner.
2. Within thirty days of receiving the avoidable reversal notice from the Reserve, the Forest Owner must provide a written description and explanation of the reversal to the Reserve.
3. Within three months of receiving the avoidable reversal notice, the Forest Owner must provide the Reserve with a verified estimate of current onsite carbon stocks.
4. Within four months of receiving the avoidable reversal notice, the Forest Owner must retire a quantity of CRTs from its Reserve account equal to the size of the reversal in CO_2-equivalent metric tonnes. In addition:

a. The retired CRTs must be those that were issued to the Forest Project, or that were issued to other Forest Projects registered with the Reserve.
b. The retired CRTs must be designated in the Reserve's software system as compensating for the Avoidable Reversal.

7.4 Disposition of Forest Projects After a Reversal

If a reversal lowers the Forest Project's actual onsite carbon stocks below its approved baseline onsite carbon stocks, the Forest Project will automatically be terminated. (In this circumstance, the original approved baseline for the project would no longer be valid.)

If the Forest Project has experienced a reversal and its actual onsite carbon stocks are still above the approved baseline levels, it may continue without termination as long as the reversal has been compensated. The project must continue contributing to the Buffer Pool in future years based on its verified risk rating.

8 Project Monitoring

Monitoring is the process of regularly collecting and reporting data related to a project's performance. Annual monitoring of Forest Projects is required to ensure up-to-date estimates of project carbon stocks and provide assurance that GHG reductions or removals achieved by a project have not been reversed. Forest Owners must conduct monitoring activities and submit monitoring reports on an annual basis. Monitoring is required for a period of 100 years following the final issuance of CRTs to a project for quantified GHG reductions or removals.

For Forest Projects, monitoring activities consist primarily of updating a project's forest carbon inventory. The Reserve requires a complete inventory of carbon stocks to be reported each year. This complete inventory must be maintained throughout the time the project is reporting to the Reserve.

8.1 Monitoring Plans

Prior to a Forest Project's first verification, the Forest Owner must establish a monitoring plan detailing the specific methods that will be used to update the project's forest carbon inventory on an annual basis. The inventory methodology detailed in this monitoring plan must adhere to the guidance in Appendix A and B, which establish the equations for computing biomass and limits to which computer models can be used in the inventory update process.

8.2 Annual Monitoring Requirements

Forest Owners are required to report the Forest Project's carbon stocks each year. The annual report must include an estimate of carbon stocks in all required and optional carbon pools. The estimate must include the appropriate confidence deduction as determined by the steps specified in Appendix A, Section A.4. Annual carbon stock estimates are computed from inventory data. Inventory data are updated annually by:

1. Incorporating any new forest inventory data obtained during the previous year. .
2. Growing previous year's sample plots using approved growth models and stand table projection methods (see Appendix B regarding growth models and stand table projections).
3. Updating the forest inventory data for harvests and/or disturbances that have occurred during the previous year.

4. Quantifying the net amount of carbon expected to be stored for 100 years in wood products harvested during the current year, following the guidance in Appendix C.

Specific methods used to update the forest inventory must follow the inventory methodology approved at the time the project is registered. Modifications to inventory methodologies must be approved in advance by a third-party verifier and by the Reserve.

9 Reporting Requirements

Reporting requirements for Forest Projects fall into two categories:

1. Forms, data, and information that must be submitted to a verifier and to the Reserve as part of a project's initial verification.
2. Forms, data, and information that must be submitted to a verifier and to the Reserve as part of annual monitoring reports.

All reports that reference carbon stocks must be submitted with the oversight of a Professional Forester. If the project is located in a jurisdiction without a Professional Forester law or regulation, then Certified Forester credentials managed by the Society of American Foresters (see www.certifiedforester.org) are required so that professional standards and project quality are maintained. The Reserve may evaluate and approve alternative certification credentials if requested, but only for jurisdictions where professional forester laws or regulations do not exist. This requirement does not preclude the project's use of technicians or other unlicensed/uncertified persons working under the supervision of the Professional Forester.

9.1 Reporting Requirements for a Forest Project's Initial Verification

The following information must be reported in a Forest Project Design Document and submitted to a verifier and to the Reserve upon a project's initial verification. Submission of this information is necessary for the project be registered with the Reserve.

9.1.1 All Projects

Forest Owners must provide the following information to verifiers at the time a Forest Project is submitted for verification and registration (note: Reforestation Projects, as qualified in Section 6.1.1, can defer the items that are marked with an asterisk until the second site verification):

1. A copy of the signed Regulatory Attestation Form, available from the Reserve website, indicating that the Forest Project's planned activities are not required by law.
2. An explanation and justification of the project start date.
3. A copy of the signed Project Implementation Agreement.
4. A copy of the signed Attestation of Title Form, available from the Reserve website, indicating an exclusive ownership claim to the GHG reductions and removals achieved by the Forest Project.
5. Declaration that the project does *not* employ broadcast fertilization.
6. If the Forest Project is located on non-federal public land, a description and copies of the documentation demonstrating explicit approval of the project's management activities and baseline including any public vetting processes necessary to evaluate management and policy decisions concerning the project activity.
7. If the Forest Project is located on federal lands, a description and copies of the documentation demonstrating approval of the project's eligibility through congressional processes.

8. If the Forest Project is located in tribal areas, a description and copies of documentation demonstrating that the land within the Project Area is owned by a tribe or private entities.
9. If commercial harvesting is either planned or ongoing within project boundaries, a description of how the Forest Owner satisfies one of the three requirements for employing and demonstrating sustainable long-term harvesting practices on all of its forest landholdings. (Refer to Section 3.9.1.)
10. A description of how the project meets (or will meet) the definition of "Natural Forest Management" (refer to Section 3.9.2), including required policies/statements of intent for management of lying and standing dead wood.
11. Descriptions and maps of the project area that include:
    a. Project Area boundaries
    b. Latitude and longitude
    c. Townships, ranges, and sections
    d. Existing land cover and land use
    e. Topography
    f. Forest vegetation types
    g. Site classes
    h. Public and private roads
    i. Major watercourses (4^{th} order or greater)
    j. Land pressures and climate zone/classification
    k. Major roads, towns, and other landmarks
12. *A description of the inventory methodology for each of the carbon pools included in the project report. The inventory methodology must describe:
    a. The stratification rules and processes, if applicable.
    b. The sampling process, including selection of plot locations, monumenting of plots, frequency of sampling efforts, data gathering procedures, and parameters of data collected.
    c. Data management and analytical systems.
    d. An inventory monitoring plan including the annual inventory update processes, and the adjustments for harvest, growth, and disturbances over time.
    e. Methods for quality control.
13. *A subset of plot data and carbon stock measurements randomly selected and requested by the verifier.
14. *A description of the calculation methodologies for determining metric tonnes per hectare for the for each of the carbon pools included in the project report.
15. *A modeling plan, following the requirements in Appendix B, Section B.3.
16. *A summary of the carbon stock inventory for the Forest Project by each pool.
17. *A summary of inventory confidence statistics.
18. *The Forest Owner's description and estimate of the Forest Project's baseline onsite carbon stocks. Baseline onsite carbon stocks must be portrayed in a graph depicting time in the x-axis and carbon tonnes in the y-axis. The graph should be supported with written characterizations that explain any annual changes in baseline carbon stocks over time. These characterizations must be consistent with the baseline analysis required in Section 6.
19. A description of the management activities that will lead to increased carbon stocks in the Project Area, compared to the baseline.
20. *A projection of anticipated actual onsite carbon stocks under the Forest Project. Project onsite carbon stocks must be portrayed in the same graph depicting the projection of baseline onsite carbon stocks. This projection should be a good faith

estimate at the time of the Forest Project's initiation and will be verified for completeness, not accuracy (actual onsite carbon stocks will be verified over time).
21. *The Forest Owner's estimate of baseline carbon that will be stored long-term in harvested wood products.
22. *Projections of baseline and actual harvesting volumes from the Project Area over 100 years.
23. *Calculation of the project's reversal risk rating and contribution to the buffer pool.

9.1.2 Reforestation Projects

In addition to the information in Section 9.1.1, Forest Owners must provide the following information at the time a Reforestation Project is submitted for verification and registration:

1. An explanation of how the project, at the time of project initiation, meets the eligibility requirements of a) less than 10 percent tree canopy cover for a minimum of 10 years; or b) subject to a significant disturbance that has removed at least 20 percent of the land's above-ground live biomass. The explanation should include why the forest was out of forest cover or a description of the disturbance if a natural significant disturbance occurred.
2. For a Reforestation Project that occurs on land that has undergone a recent Significant Disturbance, indicate the eligibility scenario pertaining to the project site as identified in Appendix E, or a description of .how the Forest Project occurs on a type of land for which the Forest Owner has not historically engaged in or allowed timber harvesting.
3. A qualitative characterization of baseline conditions, including an assessment of the likely vegetative conditions and activities that would have occurred in the absence of the project, taking into consideration any laws, statutes, regulations, or other legal mandates that would encourage or require reforestation on the Project Area. The qualitative assessment shall include an assessment of the commercial value of trees within the project area over the next 30 years.

9.1.3 Improved Forest Management Projects on Private Lands

In addition to the information in Section 9.1.1, Forest Owners must provide the following information at the time an Improved Forest Management Project on private land is submitted for verification and registration:

1. Demonstration that the project takes place on land that has greater than 10 percent tree canopy cover.
2. A determination of how the Forest Project's initial standing live carbon stocks compare to Common Practice, as required in Section 6.2.1.
3. If the Forest Project's initial standing live carbon stocks are below Common Practice, a determination of the "High Stocking Reference" for the Project Area. The High Stocking Reference is defined as 80 percent of the highest carbon stocks in live trees during the preceding 10-year period. To determine the High Stocking Reference, the Forest Owner must document changes in the Project Area's live-tree carbon stocks over the preceding 10 years, or as long as the Forest Owner has had control of the stocks. The summary report should include an affidavit testifying that the inventory depicted over the past 10 years is reasonably accurate. The affidavit must include a summary of volume harvested over the past 10 years.
4. Documentation of any and all legal constraints affecting forest management activities on the Project Area. The documentation of legal constraints must include:
    a. A description of each constraint. (Refer to Section 6.2.1.1.)

   b. A narrative that describes the effect of the constraint on forest management.
   c. A description of the modeling techniques used to simulate the effects of the constraint.
5. A demonstration that the growth and harvesting regime assumed for the baseline is financially feasible following the requirements of Section 6.2.1.2.

9.1.4 Improved Forest Management Projects on Public Lands

In addition to the information in Section 9.1.1, Forest Owners must provide the following information at the time an Improved Forest Management Project on public land is submitted for verification and registration:

1. Documentation demonstrating that the project takes place on land that has greater than 10 percent tree canopy cover.
2. A projection of future changes to Project Area forest carbon stocks by extrapolating from historical trends; and anticipating how current and future public policy will affect onsite carbon stocks per the requirements of Section 6.2.2.
3. An explanation of how current and future public policy will affect onsite carbon stocks and how, the baseline modeling incorporates constraints imposed by all applicable statutes, regulations, policies, plans and Activity-Based Funding.

9.1.5 Avoided Conversion Projects

In addition to the information in Section 9.1.1, Forest Owners must provide the following information at the time an Avoided Conversion Project is submitted for verification and registration:

1. Documentation demonstrating the planned or completed dedicating of the land in the Project Area to continuous forest cover through a conservation easement or transfer to public ownership.
2. Documentation demonstrating that the type of anticipated land use conversion is legally permissible per the requirements of Section 3.1.1.3.
3. A description of how the Project Area was determined, following the requirements in Section 4.
4. A full copy of the appraisal that was prepared for the Project Area per the requirements of Section 3.2.1.3.
5. A description of the highest value alternative land use identified in the appraisal.
6. An estimate the rate of conversion and removal of onsite carbon stocks per the requirements in Section 6.3.1.
7. A comparison of the fair market value of the anticipated alternative land use for the Project Area with the value of the current forested land use, and the calculation of an appropriate uncertainty discount (following the requirements in Section 6.3.1).

9.2 Annual Monitoring Reports

Annual monitoring reports must contain an update of the project's forest carbon inventory (Section 8.2). Each monitoring report must also contain the following additional information (note: Reforestation Projects, as qualified in Section 6.1.1, can defer the items that are marked with an asterisk until the second site verification):

1. An updated estimate of the current year's carbon stocks in all required and optional carbon pools per the requirements of the inventory methodology approved at the time

the project is registered or modifications approved in advance the a third-party verifier and by the Reserve.
2. *The appropriate confidence deduction for the forest carbon inventory, as determined at the last full site verification for the project (following the guidance in Appendix A, Section A.4). The same confidence deduction must be used in interim years between verifier site visits.
3. *An explanation for any decrease over any 10-year consecutive period in the standing live carbon pool.
4. Any changes in the status of the Forest Owner including, if applicable per Section 3.9.1,. the acquisition of new forest landholdings
5. A description of how the project meets (or will meet) the definition of "Natural Forest Management" (refer to Section 3.9.2), including progress on criteria that have not been fully met in previous years.
6. *An estimate of current-year harvest volumes and associated carbon in harvested wood products.
7. *Estimated mill efficiency, as determined following the guidance in Appendix C, Section C.2.
8. The baseline carbon stock estimates for all required and optional carbon pools for the current year, as determined following the requirements in Section 6 and approved at the time of the project's registration.
9. An estimate of Secondary Effects, following calculation steps and/or factors provided in Section 6 and approved at the time of the project's registration.
10. The uncertainty discount for avoided conversion projects, as determined following the requirements of Section 6.3 and approved at project registration. (Once a project is registered with the Reserve, the uncertainty discount does not change.)
11. A preliminary calculation of total net GHG reductions and removals (or reversals) for the year, following the requirements in Section 6.
12. If a reversal has occurred during the previous year, the report must provide a written description and explanation of the reversal, whether t the Reserve classified the reversal as avoidable or unavoidable and the status of compensation for the reversal.
13. *The project's reversal risk rating, as determined following the requirements in Section 7 and Appendix D. The risk rating is updated during each full site-verification. Between verifier site visits, the project's reversal risk rating does not change.
14. *A preliminary calculation of the project's Buffer Pool contribution.

9.3 Transparency

The Reserve requires data transparency for all Forest Projects, including data that displays current carbon stocks, reversals, and verified GHG reductions and removals. For this reason, all non-confidential project data reported to the Reserve will be publicly available on the Reserve's website.

10 Verification

The Reserve requires that an approved third-party verifier review and assess all reported data and information to confirm that the Forest Owner has adhered to the requirements of this protocol.[9] This process is an integral component of the Reserve's program and ensures the accuracy, consistency, and credibility of reported assertions about the GHG reductions and removals achieved by a project. This section describes general verification requirements for

[9] A list of approved verification bodies is provided on the Reserve's website at http://www.climateactionreserve.org.

Forest Projects. Detailed methods for verification are described in a separate document, the Forest Verification Protocol.

10.1 Initial Verification

Forest Projects must be verified with a site visit before they can be registered with the Reserve. The initial site verification is critical to ensure that the project is eligible to be registered and that the project's baseline is correctly estimated. The verifier must assess all project documentation and ensure all of the reporting requirements identified in Section 9 have been fulfilled.

10.2 Ongoing Verification

After a project is registered, verifier site visits must occur at least once every six years. The only exception is for Reforestation Projects, for which a second verifier site visit can be deferred indefinitely. If the second verifier site visit is deferred, the Reserve will only issue CRTs once a second site visit verification is completed. The Reforestation Project must then undergo verifier site visits on a six year cycle. Verifier site visits are also required anytime the Forest Owner would like to establish new confidence deductions and/or project risk ratings. In years when the project is not subject to a site visit, annual monitoring reports must be submitted to a verifier for desk review.

All GHG reductions and removals quantified over the course of a project are considered reversed if a Forest Owner, or subsequent landowner, chooses not to undergo verification. The reversal must be compensated by retiring CRTs as described in Section 7.2.2.

10.2.1 Verifier Site Visits

After initial verification (Section 10.1), subsequent site visits must assess and ensure accuracy in:

1. Forest carbon inventory methodologies and estimates
2. Confidence levels for inventory data
3. Status and progress on meeting criteria for sustainable harvesting and Natural Forest Management Practices
4. The project's reversal risk rating
5. Accuracy of reported data and information

The methods for verification are described in the Forest Verification Protocol.

10.2.2 Verifier Desk Reviews

Between site visits, an approved third-party verification body must conduct a desk review of annual monitoring reports. The verifier will review the data in the report to check it for reasonability, accuracy, and completeness. In particular, the verifier will review and confirm the following information (Table 10.1).

Table 10.1. Information Reviewed in Verifier Desk Review

Reported Information:	Verifier Confirms Using:
The carbon associated with harvest events in terms of effects on onsite stocks and effects on harvested wood products during the previous year	▪ Harvest reports prepared by the Forest Owner. ▪ Harvest data submitted to agencies.
The carbon associated with forest growth during the previous year.	▪ Estimates of growth provided by Forest Owner. The verifier shall determine if reported growth is reasonable based on professional judgment.
Any disturbances that have impacted more that 1% of the project carbon that have occurred within the previous year.	▪ Reports submitted by Forest Owner. ▪ Regional and State data identifying disturbance sites.

10.3 Issuance of CRTs

The Reserve will issue CRTs for quantified GHG reductions or removals that have been verified through either site visits or desk reviews.

11 Glossary of Terms

Above-Ground Live Biomass	Live trees including the stem, branches, and leaves or needles, brush and other woody live plants above ground.
Activity-Based Funding	The budget line items that are dedicated to agency accomplishments in vegetation management, including pre-commercial thinning, commercial thinning, harvest, hazard tree removal, hazardous fuel reductions, and other management activities designed to achieve forest sustainability health objectives.
Additionality	A criterion for Forest Project eligibility. A Forest Project is "additional" if it would not have been implemented without incentives provided by the carbon offset market, including the incentives created through the Climate Action Reserve program. Under this protocol, Forest Projects meet the additionality criterion by demonstrating that they pass a legal requirements test and a performance test, as described in Section 3.1, and by achieving GHG reductions and removals quantified against an approved baseline, determined according to the requirements in Section 6.
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.
Assessment Area	A distinct forest community within geographically identified ecoregions (see Appendix F) defined by the Reserve that consists of common regulatory and political boundaries that affect forest management. The size of the Assessment Areas is determined by efforts to achieve optimal statistical confidence across multiple scales using U.S. Forest Service Forest Inventory and Analysis Program (FIA) plots for biomass. Maps of the Assessment Areas and the associated data may be found on the Reserve's website.
Avoidable Reversal	An avoidable reversal is any reversal that is due to the Forest Owner's negligence, gross negligence, or willful intent, including harvesting, development, and harm to the Project Area due to the Forest Owner's negligence, gross-negligence or willful intent.

Avoided Conversion Project	A type of Forest Project consisting of specific actions that prevent the conversion of forestland to a non-forest land use by dedicating the land to continuous forest cover through a conservation easement or transfer to public ownership.
Baseline	The level of GHG emissions, removals, and/or carbon stocks at sources, sinks, or reservoirs affected by a Forest Project that would have occurred under a Business-As-Usual scenario. For the purposes of this protocol, a project's baseline must be estimated following standard procedures in Section 6.
Best Management Practices	Management practices determined by a state or designated planning agency to be the most effective and practicable means (including technological, economic, and institutional considerations) of controlling point and nonpoint source pollutants at levels compatible with environmental quality goals.[10]
Biological Emissions	For the purposes of the Forest Project Protocol, biological emissions are GHG emissions that are released directly from forest biomass, both live and dead, including forest soils. For Forest Projects, biological emissions are deemed to occur when the reported tonnage of onsite carbon stocks, relative to baseline levels, declines from one year to the next.
Biomass	The total mass of living organisms in a given area or volume; recently dead plant material is often included as dead biomass.[11]
Bole	A trunk or main stem of a tree.
Broadcast Fertilization	A fertilizer application technique where fertilizer is spread across the soil surface.
Buffer Pool	The Buffer Pool is a holding account for Forest Project CRTs administered by the Reserve. It is used as a general insurance mechanism against unavoidable reversals for all Forest Projects registered with the Reserve. If a Forest Project experiences an unavoidable reversal of GHG reductions and removals (as defined in Section 7.3), the Reserve will retire a number of CRTs from the Buffer Pool equal to the total amount of carbon that was reversed (measured in metric tonnes of CO_2-equivalent).
Business As Usual	The activities, and associated GHG reductions

[10] (Helms 1998)
[11] (Metz, Davidson, Swart, & Pan, 2001)

	and removals that would have occurred in the Project Area in the absence of incentives provided by a carbon offset market. Methodologies for determining these activities – and/or for approximating carbon stock levels that would have resulted from these activities – are provided in Section 6 of this protocol for each type of Forest Project.
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.
Climate Reserve Tonne	The unit of offset credits used by the Climate Action Reserve. Each Climate Reserve Tonne represents one metric tonne (2204.6 lbs) of CO_2 reduced or removed from the atmosphere.
Common Practice	The average stocks of the live standing carbon pool from within the Forest Project's Assessment Area, derived from FIA plots on all private lands within the defined Assessment Area.
Even-Aged Management	Management where the trees in individual forest stands have only small differences in their ages (a single age class). By convention, the spread of ages does not differ by more than 20% of the intended rotation.
FIA	USDA Forest Service Forest Inventory and Analysis program. FIA is managed by the Research and Development organization within the USDA Forest Service in cooperation with State and Private Forestry and National Forest Systems. FIA has been in operation under various names (Forest Survey, Forest Inventory and Analysis) for 70 years.
Forest Management	The commercial or noncommercial growing and harvesting of forests.
Forest Owner	A Forest Owner is a corporation or other legally constituted entity, city, county, state agency, individual, or a combination thereof, that executes the Project Implementation Agreement, as described in Section 2.2. of the this Forest Protocol.
Forest Project	A planned set of activities designed to increase removals of CO_2 from the atmosphere, or reduce or prevent emissions of CO_2 to the atmosphere, through increasing and/or conserving forest carbon stocks.

Forest Project Design Document	A standard document for reporting required information about a Forest Project. The Forest Project Design Document must be submitted for review by a verifier and approved by the Reserve before the Forest Project can be registered with the Reserve.
Forestland	Land that supports, or can support, at least 10 percent tree canopy cover and that allow for management of one or more forest resources, including timber, fish and wildlife, biodiversity, water quality, recreation, aesthetics and other public benefits.
GHG Assessment Boundary	The GHG Assessment Boundary defines all the GHG sources, sinks, and reservoirs that must be accounted for in quantifying a Forest Project's GHG reductions and removals (Section 6). The GHG Assessment Boundary encompasses all the GHG sources, sinks, and reservoirs that may be significantly affected by Forest Project activities, including forest carbon stocks, sources of biological CO_2 emissions, and mobile combustion GHG emissions.
GHG Reductions and Removals	See definitions for Reduction and Removal.
Greenhouse Gases (GHG)	Gases that contribute to global warming and climate change. For the purposes of this Forest Project Protocol, GHGs are the six gases identified in the Kyoto Protocol: Carbon Dioxide (CO_2), Nitrous Oxide (N_20), Methane (CH_4), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and Sulfur Hexafluoride (SF_6).
Improved Forest Management Project	A type of Forest Project involving management activities that increase carbon stocks on forested land relative to baseline levels of carbon stocks.
Listed	A Forest Project is considered "listed" when the Forest Owner has created an account with the Reserve, submitted the required Project Submission Form and other required documents, paid the project submission fee, and the Reserve has approved and accepted the project for listing.
Litter	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 that is smaller than material identified as lying dead wood.
Lying Dead Wood	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. Lying dead wood is all dead tree material with a minimum average

	diameter of 5" and a minimum length of 8'. Anything not meeting the measurement criteria for lying dead wood will be considered litter. Stumps are not considered lying dead wood.
Native Forest	For the purposes of this protocol native forests shall be defined as those occurring naturally in an area, as neither a direct nor indirect consequence of human activity post-dating European settlement.
Natural Forest Management	Forest management practices that promote and maintain native forests comprised of multiple ages and mixed native species at multiple landscape scales. The application of this definition, its principles, detailed definition, and implementation are discussed further in the Section 3.9.2.
Non-Forest Cover	Land with a tree canopy cover of less than 10 percent.
Non-Forest Land Use	An area managed for residential, commercial, or agricultural uses other than for the production of timber and other forest products, or for the maintenance of woody vegetation for such indirect benefits as protection of catchment areas, wildlife habitat, or recreation.
Non-Harvest Disturbance	Reduction in forest cover that is not a direct result of harvest, such as wildfire and insect disturbances.
Permanence	The requirement that GHGs must be permanently reduced or removed from the atmosphere to be credited as carbon offsets. For Forest Projects, this requirement is met by ensuring that the carbon associated with credited GHG reductions and removals remains stored for at least 100 years.
Primary Effect	The Forest Project's intended changes in carbon stocks, GHG emissions, or GHG removals.
Professional Forester	A professional engaged in the science and profession of forestry. A professional forester is credentialed in jurisdictions that have professional forester licensing laws and regulations. Where a jurisdiction does not have a professional forester law or regulation then a professional forester is defined as having the Certified Forester credentials managed by the Society of American Foresters (see www.certifiedforester.org).
Project Area	The area inscribed by the geographic boundaries

	of a Forest Project, as defined following the requirements in Section 4 of this protocol. Also, the property associated with this area.
Project Life	Refers to the duration of a Forest Project and its associated monitoring and verification activities, as defined in Section 3.4.
Public Lands	Lands that are owned by a public governmental body such as a state, county, municipality, or country.
Qualified Conservation Easement	A qualified conservation easement must explicitly refer to the terms and conditions of the Project Implementation Agreement, apply to current and all subsequent Forest Owners for the full duration of the Forest Project's minimum time commitment, as defined in Section 3.4 of this protocol.
Qualified Deed Restriction	A qualified deed restriction must explicitly refer to the terms and conditions of the Project Implementation Agreement, apply to current and all subsequent Forest Owners for the full duration of the Forest Project's minimum time commitment, as defined in Section 3.4 of this protocol.
Reduction	The avoidance or prevention of an emission of CO_2 (or other GHG). Reductions are calculated as gains in carbon stocks over time relative to a Forest Project's baseline (also see Removal).
Reforestation Project	A type of Forest Project involving the restoration of tree cover on land that currently has no, or minimal, tree cover.
Registered	A Forest Project becomes registered with the Reserve when it has been verified by a Reserve-approved third-party verification body, all required documentation (see Section 10.1) has been submitted by the Forest Owner to the Reserve for final approval, and the Reserve approves the project.
Removal	Sequestration ("removal") of CO_2 from the atmosphere caused by a Forest Project. Removals are calculated as gains in carbon stocks over time relative to a Forest Project's baseline (also see Reduction).
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 captured from a source.
Retire	To retire a CRT means to transfer it to a retirement account in the Climate Action Reserve's software system. Retirement accounts

	are permanent and locked, so that a retired CRT cannot be transferred or retired again.
Reversal	A reversal is a decrease in the stored carbon stocks associated with quantified GHG reductions and removals that occurs before the end of the Project Life. Under this protocol, a reversal is deemed to have occurred if there is a decrease in the difference between project and baseline onsite carbon stocks from one year to the next, regardless of the cause of this decrease (i.e. if the result of (Δ AC_{onsite} - Δ BC_{onsite}) in Equation 6.1 is negative).
Secondary Effects	Unintended changes in carbon stocks, GHG emissions, or GHG removals caused by the Forest Project.
Sequestration	The process of increasing the carbon (or other GHGs) stored in a reservoir. Biological approaches to sequestration include direct removal of CO_2 from the atmosphere through land-use changes[12] and changes in forest management.
Significant Disturbance	Any natural impact that results in a loss of least 20% of the above-ground live biomass that is not the result of intentional or grossly negligent acts of the Forest Owner.
Sink	Physical unit or process that removes a GHG from the atmosphere.
Source	Physical unit or process that releases a GHG into the atmosphere.
Standing Dead Carbon Stocks	The carbon in standing dead trees. Standing dead trees include the stem, branches, roots, or section thereof, regardless of species, with minimum diameter (breast height) of five inches and a minimum height of 15 feet. Stumps are not considered standing dead stocks.
Standing Live Carbon Stocks	The carbon in the live tree pool. Live trees include the stem, branches, roots, and leaves or needles of all above ground live biomass, regardless of species, with a minimum diameter (breast height) of five inches and a minimum height of 15 feet.
Stocks (or Carbon Stocks)`	The quantity of carbon contained in identified. carbon pools.
Submitted	The Reserve considers a Forest Project to be

[12] (Metz, Davidson, Swart, & Pan, 2001)

	"submitted" when all of the appropriate forms have been uploaded and submitted to the Reserve's software system, and the Forest Owner has paid a project listing fee.
Tree	A woody perennial plant, typically large and with a well-defined stem or stems carrying a more or less definite crown with the capacity to attain a minimum diameter at breast height of 3 inches and a minimum height of 15 feet with no branches within 3 feet from the ground at maturity.[13]
Unavoidable Reversal	An unavoidable reversal is any reversal not due to the Forest Owner's negligence, gross negligence or willful intent, including wildfires or disease that are not the result of the Forest Owner's negligence, gross negligence or willful intent.
Uneven-Aged Management	Management that leads to forest stand conditions where the trees differ markedly in their ages, with trees of three or more distinct age classes either mixed or in small groups.
Verification	The process of reviewing and assessing all of a Forest Project's reported data and information by a third-party verifier approved by the Reserve, to confirm that the Forest Owner has adhered to the requirements of this protocol.

[13] (Helms 1998)

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Appendix A Developing an Inventory of Forest Project Carbon Stocks

This appendix provides requirements for quantifying a Forest Project's forest carbon stocks. It explains how to identify the required and optional forest carbon pools measured in a Forest Project, as well as the steps necessary for quantifying the existing carbon stocks in the selected pools within the Project Area. Carbon inventory information serves two purposes:

1. It is used as the basis for modeling and estimating carbon stocks in a project's baseline (following the requirements of Section 6).
2. It is used to quantify actual carbon stocks during the course of a project.

This appendix explains the essential steps and requirements for completing a carbon inventory for all required and optional onsite carbon pools associated with a Forest Project. Table A.4 contains a worksheet that must be followed to quantify the carbon in each of pool.

A.1 Provide Background Information on Forest Area

To begin the inventory process, develop a general description of the activities and land use patterns that influence carbon stocks in the Project Area. This information will help inform the initial design of the forest inventory, as well as the estimations of carbon stocks. This information will be reviewed during verification.

At the time the Forest Project is fist verified, the following information must be provided in narrative or map form, as appropriate:

- Project Area boundaries (as determined in Section 4)
- Latitude and longitude of the Project Area
- Existing land cover and land use
- Topography
- Forest vegetation types
- Site classes
- Watercourses in area (4^{th} order or greater)
- Land pressures and climate zone/classification

A.2 Measure Carbon Pools in the Project Area

Forest carbon pools are broadly grouped into the following categories:

1. Living biomass
2. Onsite dead biomass
3. Soil
4. Offsite dead biomass (wood products)

Values for some of these categories of carbon will be determined through direct sampling. Table A.1 indicates the categories with their associated carbon pools and identifies which pools must be quantified for all projects versus those that may be excluded depending on the project. It also shows how the value for the pool is determined.

Table A.1. Reserve requirements of carbon pool categories and determination of value for pool

Category	Carbon Pool	Forest Management	Reforestation	Avoided Conversion	Determination of Value
Living biomass	Standing Live	Required	Required*	Required	Sampled in Project
	Shrubs and Herbaceous Understory	Optional	Required	Optional	Sampled in Project
Onsite dead biomass	Standing Dead	Required	Required	Required	Sampled in Project
	Lying Dead Wood	Optional	Optional	Optional	Sampled in Project
	Litter	Optional	Optional	Optional	Sampled in Project
Soil	Soil**	Optional**	Optional**	Optional**	Sampled in project
Off-site dead biomass	Wood Products	Required	NA	Required	Decay calculation from volume of harvested wood

* Pre-existing trees must be distinguished from planted trees. Since pre-existing and new trees are easy to distinguish for several decades after tree planting, pre-existing trees do not need to be inventoried until the Forest Owner first seeks verification of GHG reductions and removals (subsequent to the project's initial site verification and registration).
** Soil carbon is not anticipated to change significantly as a result of most Forest Project activities. Soil carbon must be included in the inventory, however, if any of the following activities occur:

- Site preparation activities involve deep ripping, furrowing, or plowing where soil disturbance exceeds 25 percent of the Project Area, or
- Mechanical site preparation activities are not conducted on contours.

A.3 Developing Onsite Forest Carbon Inventories

To develop estimates of carbon stocks in the carbon pools identified in Table A.1, a forest inventory must first be conducted. Standard forest inventories require the establishment of sample plots and provide inventory estimates in terms of cubic or board foot volume. These measurements are based on the species, trunk or bole diameter, form and height of the tree. A complete inventory must include a sampling methodology, a set of inventory plots, and analytical methods to translate field measurements into volume and/or biomass estimates.

Allometric Equations and Biomass/Carbon Mass Estimates

The equations in this appendix should be used for biomass and carbon mass estimations using the bole diameter and total height for live trees and sound standing dead trees. Estimates of lying dead and standing dead tree (for non-sound trees) biomass should be computed in terms of cubic volume and subsequently converted to biomass/carbon mass estimates. The Reserve may grant approval to use different volumetric and allometric equations than those presented here. The equations must be demonstrated to be more accurate within the project's Assessment Area than the equations currently in use by the USFS. The equations can only be approved with approval of a state forestry authority (i.e. a person meeting the definition of Professional

Forester who is employed by a state agency responsible for the oversight of forests) who will acknowledge in writing that the equation is an improvement. The Reserve will publish the improved equation and resulting measure of Common Practice for the Assessment Area. This is required to maintain consistency between the estimates of Forest Project carbon stocks and the Reserve's estimates of Common Practice for Improved Forest Management Projects.

Sample Plots

The plot data used for deriving the estimates for verification must have been sampled within the last 12 years. The scheduling of plot sampling may occur in one time period or be distributed over several time periods. Either approach is acceptable so long as an inventory of the entire Project Area (its required carbon pools and corresponding sample plots) is completed within 12-year intervals.

An exception to the 12-year plot life is accepted where the Forest Owner can demonstrate to the verifier that the process utilized for updating the inventory, addressing both forest growth and harvest, adequately estimates the current inventory. To accomplish this, a statistically valid subsampling that has at least 10% of the plot numbers included in the updated inventory must be completed and determined to be the same as the updated inventory (updated using computer simulation that incorporates harvests) with a 90% confidence (α=0.10). Below is an example of the test assuming the plots are not paired and assuming they are paired. In no case shall any plot measurements be more than 18 years old.

The hypotheses are:

H_0: the subsample and updated inventory are the same
H_A: the subsample and updated inventory are not the same

The formula for the test statistic (t) is:

$$t = \frac{\left(\overline{x}_u - \overline{x}_s\right)}{s_{\overline{d}}}$$

Where: $\overline{x}_u$ = the updated carbon estimate from the original inventory

$\overline{x}_s$ = the subsample carbon estimate

$s_{\overline{d}}$ = the standard error of the difference between the two estimates (which is explained below for the situation where plots are unpaired and paired)

The standard error calculation for unpaired plots, which may occur with temporarily located plots, assumes that the variance is the same for both estimates since they are from the same population. The standard error estimate is given as:

$$s_{\overline{d}} = \sqrt{\frac{\left(\frac{\left(n_u \times s_u^2\right)+\left(n_s \times s_s^2\right)}{\left(n_u - 1\right)+\left(n_s - 1\right)}\right)}{n_u + n_s}}$$

Where: s_u^2 = the variance or standard deviation squared of the updated sample

s_s^2 = the variance or standard deviation squared of the subsample

n_u and n_s = the sample size of the updated inventory and subsample respectively

A one-tailed Students t-value is taken from a table using the α=0.10 and a degree of freedom of $n_u + n_s - 2$. If t < t(table) then accept H_0, otherwise reject H_0.

Where the plots are paired, as with re-measured permanent plots, then the standard error estimate is given as:

$$s_{\bar{d}}^2 = \sqrt{\frac{s_d^2}{n}}$$

Where: s_d^2 = the variance or standard deviation squared of the plot differences

n = the number of plots

The t-value from the table uses n - 1 degrees of freedom.

Steps for Developing a Complete Forest Carbon Inventory

The steps that follow provide more detailed guidance to establish and maintain a complete inventory and estimate carbon stocks. Results must be summarized in a table, as indicated in Step 8, for reports submitted to verifiers and to the Reserve (see Section 9).

Step 1 – Developing Inventory Methodology and Sample Plots

Forest Owners must develop and describe a methodology to sample for biomass or volume of all required carbon pools. Sampling methodologies are also required for all included optional carbon pools, where a determination of the biomass or volume must be derived from sampling. Section 12 contains recommended references for developing sampling methodologies. If a pre-existing forest inventory is used to develop a Forest Project carbon inventory, all steps here must be followed to ensure the existing inventory meets the requirements of this protocol.

Sampling methodology and measurement standards should be consistent throughout the duration of the Forest Project. If new methodologies are adopted, they must achieve an equal or greater accuracy relative to the original sampling design. All sampling methodologies and measurement standards must be statistically sound and must be approved during verification.

Stratification is not required, but it may simplify verification and possibly lower the costs of verification. Temporary flagging of plot center, as is customary to allow for check cruising, is required to ensure ongoing inventory quality and allow for verifiers to visit plots when verifying inventory procedures. If permanent plots are used, which are statistically efficient for stock change estimates, permanent plot monumenting must be sufficient for relocation. Plot centers should be referenced on maps, preferably with GPS coordinates. The methodologies utilized must be documented and made available for verification and public review. The design of the sampling methodology and measurement standards must incorporate the requirements in the following table.

Table A.2. Minimum required sampling criteria for estimated pools

Carbon Pool	Name of Requirement	Description of Requirement
Standing Live Trees (above-ground portion)	Diameter (breast height) Measurements	Stated minimum diameter in methodology not to be greater than 5 inches (12.7 cm).
	Measurement Tools	Description of tools used for height measurement, diameter measurement, and plot measurement.
	Measurement Standards	The methodology shall include a set of standards for tree and plot size measurements.
	Plot Layout	A description of plot layout.
	Merchantability of Trees	The methodology shall include all trees regardless of current merchantability to be included in the sampling design.
	Allometric Equation used for Estimating Biomass	The methodology must include a description of the allometric equation used to estimate the whole tree biomass (bole, branches, and leaves) from bole diameter measurements. The use of functions other than those provided in the protocol will need to be approved by the verifier.
Standing Live Trees (below-ground portion)	Plot-level Allometric Equation used for Estimating Biomass	Apply model (Cairns, Brown, Helmer, & Baumgardner, 1997) to estimate below-ground biomass density. This model equation is based on above-ground biomass density in tonnes per hectare. The use of a function other than that provided in the protocol will need to be approved by the Reserve.
Herbaceous Understory	Sampling Methodology	The Reserve recommends the sampling methodology prepared by Brown, Shoch, Pearson, & Delaney (2004). This methodology is referenced in Section 12. Alternative methodologies will need to be reviewed and approved by the Reserve.
Standing Dead Trees	Diameter (breast height) and top Diameter Measurements	Stated minimum breast height diameter in methodology not to be greater than 5 inches. The minimum height of standing dead trees is 15'. Description of how top diameter is derived.
	Measurement Tools	Description of tools used for height, diameter and plot measurement.
	Measurement Standards	The methodology shall include a set of standards for height and diameter measurements.
	Plot Layout	A description of plot layout (may be the same layout as for live tree biomass).
	Merchantability of Trees	The methodology shall include all trees regardless of current merchantability to be including in the sampling design.
Litter and Duff	Sampling Methodology	The Reserve recommends the litter and duff methodology prepared by Brown, Shoch, Pearson, & Delaney (2004). This methodology is referenced in Section 12. Alternative methodologies will need to be reviewed and approved by the Reserve.
Lying Dead Wood	Diameter	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. Lying dead wood is all dead tree material with a minimum average diameter of 5" and a minimum length of 8'. Anything not meeting the measurement criteria for lying dead wood will be considered litter. Stumps are not considered lying dead wood.
	Measurement Tools	Description of tools used for length, diameter and plot measurement.
	Measurement Standards	The methodology shall include a set of standards for height and

		length measurements.
	Plot Layout	A description of plot layout (may be the same as the layout for live tree biomass).
	Merchantability of Trees	The methodology shall include all trees regardless of current merchantability to be including in the sampling design.
	Density by Decay Class	Description of methodology used to derive density estimates for each species (group) by wood density class.

Step 2 – Estimating Carbon in Live Trees from Sample Plots

Standing live tree carbon estimates are required for all projects. The standing live tree estimate includes carbon in all portions of the tree, including the bole, stump, bark, branches, leaves, and roots. The Forest Owner is responsible for determining appropriate methodologies for sampling to determine standing live tree carbon stocks. The estimate of above-ground live tree biomass must be combined with the estimates of biomass from other carbon pools to determine a mean estimate of the included pools derived from sampling, along with a summary that describes the statistical confidence of the estimate. Biomass estimates are converted to carbon estimates as described below.

The equations in Table A.3 are provided for a few common California species for estimating tree biomass from diameter (DBH) and total height (HT) measurements. This list does not contain all species that may be encountered in a Forest Project. The references in Section 12 contain a comprehensive list of biomass equations.[14]

For the equations below, diameter measurements are in inches and height measurements are in feet. The bole total volume (VOL) is calculated first and then multiplied by the wood density value for each species. This result is divided by 2.204622 to convert from pounds to kilograms. Conifer species have separate functions for bole, live crown, and bark biomass. Some hardwood species have volume functions that include these elements and therefore only one equation is used. The appropriate volume function for each species is cited in the references, which are Means, Hansen; Koerper, Alaback, & Klopsch (1994) and Waddell & Hiserote (2005).

Table A.3. Sample of the Equations for Tree Species Biomass Estimates

Species	Bole Biomass (kg)	Bark Biomass (kg)	Live Crown Biomass (kg)
Douglas-fir	(VOL * 28.70) / 2.204622	Exp(-4.3103+2.43*ln(DBH*2.54))	Exp(-3.6941+2.1382*ln(DBH*2.54))
Ponderosa pine	(VOL * 23.71) / 2.204622	Exp(-3.6263+1.34077*ln(DBH*2.54)+ 0.8567*ln(HT*0.3048))	Exp(-4.1068+1.5177*ln(DBH*2.54)+ 1.0424*ln(HT*0.3048))
Coast redwood	(VOL * 21.22) / 2.204622	Exp(7.189689+1.58375*ln(DBH*2.54))/1000	0.199+0.00381*(DBH*2.54)^2*(HT*0.3048)
Tanoak*	(VOL * 36.19) / 2.204622		
*Tanoak biomass is in one equation because the bole, bark and crown volume is in one equation.			

The derived estimate of biomass must be multiplied by 0.5 to calculate the mass (kg) in carbon. This product must be multiplied by 0.001 tonnes/kg to convert the mass to metric tonnes of carbon.

[14] The Reserve may approve the application of equations that are more accurate and equally or more conservative than those referenced here, after receiving feedback from experts at USFS research stations.

Because of the difficulties associated with measuring the below-ground carbon component of trees, the Reserve allows for the estimation of this component of tree carbon through the use of a regression equation (Cairns, Brown, Helmer, & Baumgardner, 1997). This equation provides a practical and cost-effective approach that estimates below-ground biomass of standing live trees using the sampling-based calculation of above-ground biomass of standing live trees only:

$$BBD = \exp(-0.7747 + 0.8836 * \ln(ABD))$$

Where:

BBD = below-ground biomass density of standing live trees in tonnes per hectare
ABD = above-ground biomass density of standing live trees in tonnes per hectare

This equation must be applied at the plot level, after estimates of above-ground biomass have been calculated as described above.

Example A.1. Quantification Example (Part III – Tree Biomass)

The chart below displays summary data for tree biomass for the first plot in Strata 1.

Tree Biomass

1	2	3	4	5	6	7	8	9
Plot	Tree Number	Species	DBH (cm)	Total Height (m)	Status	Biomass (kg)	Weight (Expansion per Hectare)	Biomass (kg per Hectare)
1	1	Redwood	65	32	L	2,560	21	53,768
1	2	Douglas-fir	65	29	L	2,007	21	42,152
1	3	Tanoak	28	14	L	280	112	31,402
1	4	Redwood	68	30	L	2,677	19	50,858
1	5	Redwood	76	27	L	3,086	15	46,287
1	6	Douglas-fir	65	34	L	2,310	21	48,501
1	7	Tanoak	42	17	L	729	50	36,442
1	8	Tanoak	46	18	L	914	41	37,464
							Total	346,874

The plot in this example was measured using a 30 square foot basal area factor prism. The plot number is entered in column 1. All 'in' trees (trees on the plot) are measured and input consecutively starting at North and proceeding clockwise (this facilitates check cruising, quality control). Each tree is numbered (column 2), the species documented (column 3), the DBH measurements entered as centimeters in column 4, and the total height entered as meters in column 5.

The status of the tree goes in column 6. The status codes are shown below.

Status Codes	Description
L	Live
D1	Dead, with large and small branches and twigs
D2	Dead, with large and small branches and no twigs
D3	Dead, with large branches only
D4	Dead, with no branches

Only live trees are input into the Tree Biomass worksheet. The biomass for each tree is determined (column 7) using the volume, mass, and allometric equations provided in Step 2. The basal area

factor and each tree's diameter (breast height) are used to determine the expansion factor, or weight, of each tree (column 8). The expansion factor is multiplied by each tree's biomass to portray the biomass estimate of each tree on a per hectare basis (column 9). Each tree's expanded biomass is summed to calculate the estimated total biomass in trees on plot 1. Plot 1's estimate of above-ground tree biomass in Strata 1 is calculated to be 346,874 kilograms per hectare. Based on this estimate, an estimate of below-ground biomass on a per hectare basis can be calculated using the equation above. The estimate of below-ground biomass is 80,918 kilograms per hectare. The combined estimate of biomass in Plot 1 is 427,792 kilograms per hectare.

Step 3 – Estimating Carbon Standing Dead Tree Carbon from Sample Plots

An inventory of carbon stocks in standing dead tree carbon is required for all Forest Projects. The Forest Owner must provide a sampling methodology for standing dead tree carbon as part of an overall sampling strategy (discussed in Step 1). References for developing sampling methodologies are included in Section 12. The estimate of standing dead tree carbon for highly decayed trees (broken tops, missing branches, etc.), must be calculated first volumetrically and subsequently converted to biomass and carbon tonnes. Sound dead trees can be computed using the equations provided for live trees in Step 2. The equations used in Step 2 provide an estimate of biomass in kilograms. The estimate must be converted to metric tonnes of carbon by multiplying the result by 0.001 tonnes/kg.

For those trees where volume is computed, the volume will need to be converted to biomass density by applying conversion factors based on a sub-sample of material that represents the species groups and decomposition classes. The methodology developed for both lying dead wood and standing dead biomass must include a description of the calculation techniques used to determine biomass density by decomposition classes and species groups. The estimate of biomass density must be computed in terms of metric tonnes of carbon on a per hectare basis. A description of a methodology to generate the density factors can be found in the Brown, Shoch, Pearson, & Delaney (2004) document mentioned in Table A.2. Alternatively, the density factors by decay class from Harmon et al (2008) may be used to estimate density in standing dead trees.

Step 4 – Estimating Carbon in Lying Dead Wood

The carbon content of lying dead wood, i.e. wood biomass that is not standing, is an optional pool for Forest Projects. Lying dead wood is defined as dead woody material with a minimum 6" average diameter and a minimum length of 8". As with standing dead wood, this category may not be present initially. It should be considered in the monitoring process and any projections of entity carbon stocks. References for developing sampling methodologies, which are referenced in Section 12, include Brown (1974), Harmon and Sexton (1996), and Brown, Shoch, Pearson, & Delaney (2004).

Field measurements of lying dead wood enable the calculation of volume to be easily computed. The computed volume will need to be converted to biomass density by applying conversion factors that may be based on default density values according to decay class found in Harmon et al. (2008) or a sub-sample of material that represents the species groups and decomposition classes. If direct sampling is used then the methodology developed for lying dead wood must include a description of the calculation techniques used to determine biomass density by decomposition classes and species groups. The estimate of biomass density must be computed in terms of carbon tonnes on a per hectare basis. The carbon tonnes estimate is inserted into the worksheet in this appendix. A description of a methodology to generate the density factors, if

direct sampling is used, can be found in the Brown, Shoch, Pearson, & Delaney (2004) document.

The estimate of carbon tonnes for the lying dead pool and the standing dead pool may be summed with the live tree pool for each sampled plot. This will provide the basis for determining the overall carbon tonne estimate and descriptive statistics for the pools, including wood products, if applicable. The overall carbon tonne (per hectare) estimate of the required pools and the descriptive statistics are input into the worksheet in Step 10.

Example A.2. Quantification Example (Part V – Lying Dead Wood)

Lying dead wood is sampled on every plot. The chart below displays summary data for lying dead biomass for the first plot in Strata 1.

Strata 1										
Lying Dead Wood										
1	2	3	4	5	6	7	8	9	10	11
Plot	Log Number	Species	Large end Diameter	Small end Diameter	Total Length on plot (mt)	Density	Volume (cubic meters)	Biomass (kg)	Weight (per Hectare)	Total Biomass per Hectare
1	1	Tanoak	30	15	3.6	Rotten	0.6	24.0	25	600
1	2	Redwood	109	96	2.3	Sound	1.9	684.0	25	17,100
							Sum			17,700

The sampling method used in this example is a fixed area plot. The area sampled is a 1/25th hectare plot. The entries in the columns are similar to those already discussed for trees and standing dead trees. The volume in lying dead wood is calculated first and subsequently converted to biomass using the coefficients developed from the density sub-samples.

The sum of the per hectare biomass estimates from the tree, standing dead, and lying dead biomass are summed to determine the combined biomass estimate on Plot 1. The result of summing this example is shown below.

Plot 1		
Carbon Pool	**Biomass Sum per Hectare (kg)**	**Metric Tonnes of Carbon per Hectare**
Trees	427,792	213.9
Standing Dead	57,054	28.5
Lying Dead	17,700	8.9
Total Biomass	502,546	251.3

The biomass sums are multiplied by 0.5 to convert to carbon biomass and subsequently by 0.001 tonnes/kg to convert to metric tonnes of carbon, as described in Step 2. This process is completed for all plots in Strata 1 and Strata 2. The sample results from Plot 1 indicate that there are 251 carbon tonnes per hectare.

Step 5 – Estimate Carbon in Shrubs and Herbaceous Understory from Sample Plots

Any methodology developed for measuring carbon in shrubs must be reviewed during verification. Section 12 provides a reference that can be used to predict above-ground biomass of plant species in early successional forests of the western Cascade Ranges. Inventory estimates for shrubs must be computed in terms of metric tonnes of carbon.

The most applicable biomass estimation methods may be used, including photo series, the estimation functions from published papers, direct sampling, or combinations of approaches.

Step 6 – Estimate of Carbon in Litter and Duff

Litter is the dead plant material that can still be identified as leaves, grasses and small branches. The largest material that can be considered litter is the minimum diameter stated in the Forest Project's approved methodology for lying dead wood. The duff layer is the organic material layer at the soil surface under the litter layer. The duff layer consists of dead plant materials that cannot be identified as leaves, grasses, and small branches. Carbon stock estimates must be computed in terms of metric tonnes of carbon. The mean estimate is input into the Litter and Duff Section in the worksheet in Step 8 on a per hectare basis.

The most applicable biomass estimation methods may be used, including photo series, the estimation functions from published papers, direct sampling, or combinations of approaches.

Step 7 – Estimate of Carbon Tonnes in Soil

Changes in total soil carbon are a challenge to measure over short timeframes, as this pool changes slowly and is usually dependent on the rate of biomass input relative to soil decomposition. The sampling methodology and protocols for deriving carbon estimates in soil must be developed as part of an overall sampling strategy (discussed in Step 2). The Reserve recommends the soil sampling methodology prepared by Brown, Shoch, Pearson, & Delaney (2004) that can be found in Section 12.

Estimates must be computed in terms of metric tonnes of carbon.

Step 8 – Sum Carbon Pools

The metric tonnes of carbon in each carbon pool, as derived from the preceding steps, must be entered in the following table. For the purpose of quantifying GHG reductions and removals in Section 6, all numbers must be converted to metric tonnes of CO_2-equivalent by multiplying by 3.67.

Table A.4. Worksheet for Summarizing Carbon Pools and Calculating Total Carbon

Carbon Pool	Gross Carbon Tonnes per Hectare	Gross CO_2-equivalent Tonnes per Hectare
Step 2 Live Trees	From sampling results of trees.	
Steps 3 – 4 Standing Dead Trees, and Lying Dead Wood	From sampling results of standing dead biomass and lying dead biomass.	
Step 6 Shrubs and Herbaceous Understory	From sampling results of shrubs and herbaceous understory.	

Step 7 Litter and Duff	From sampling results of litter and duff.	
Step 8 Soil	From sampling results of soil.	
Sum of CO_2-equivalent Tonnes from Included Pools		

A.4 Applying a Confidence Deduction

Any forest carbon inventory estimate will be subject to statistical uncertainty. Where statistical confidence is low, there is a higher risk of overestimating a project's actual carbon stocks and therefore a higher risk of over-quantifying GHG reductions and removals. To help ensure that estimates of GHG reductions and removals are conservative, Forest Owners are required each year to apply a confidence deduction to the inventory of actual onsite carbon stocks. A confidence deduction is *not* applied to the forest carbon inventory when it is used to model baseline carbon stocks.

To determine the appropriate confidence deduction, the Forest Owner must perform the following:

1. Compute the standard error of the inventory estimate (based on the carbon in standing live and standing dead carbon pools).
2. Multiply the standard error by 1.645.
3. Divide the total inventory estimate by the result in (2) and multiply by 100. This establishes the sampling error (expressed as a percentage of the mean inventory estimate from field sampling) for a 90% confidence interval.
4. Consult Table A.5 to identify the percent confidence deduction that must be applied to the inventory estimate for the purpose of calculating GHG reductions and removals (i.e. variable CD_y in Equation 6.1 in Section 6).

Table A.5. Forest carbon inventory confidence deductions based on level of confidence in the estimate derived from field sampling.

Sampling Error (% of Inventory Estimate)	Confidence Deduction
0 to 5%	0%
5.1 to 20%	(Sampling Error – 5.1%) to the nearest $1/10^{th}$ percentage
20% or greater	100%

The confidence deduction must be updated each time the project is subject to onsite verification (see Section 10.2), but must remain unchanged between verification site visits. If increased sampling over time results in a lower confidence deduction at the time of onsite verification, the lower deduction may be applied to inventory estimates in all previous years. The Reserve will issue CRTs in the current year for any increase in quantified GHG reductions and removals in prior years associated with the new (lower) confidence deduction.

Appendix B Modeling Carbon Stocks

This protocol requires the use of certain empirical-based models to estimate the baseline carbon stocks and project stocks of selected carbon pools within the Project Area. These models may also be used to supplement assessments of actual changes in carbon stocks resulting from the Forest Project.

B.1 About Models and Their Eligibility for Use with Forest Projects

Empirical-based models are used for estimating existing values where direct sampling is not possible or cost-effective. They are also used to forecast the estimations derived from direct sampling into the future. Field measurements provide the basis for inferring value through the use of these models.

The models that simulate growth projections have two basic functions in the development and management of a forest project. Models project the results of direct sampling through simulated forest management activity. These models, often referred to as growth and yield simulation models, may project information regarding tree growth, harvesting, and mortality over time – values that must ultimately be converted into carbon in an additional step. Other models may combine steps and estimate tree growth and mortality, as well as changes in other carbon pools and conversions to carbon, to create estimated projections of carbon stocks over time.

Models are also used to assist in updating inventory plots so that the plots can represent a reporting year subsequent to their actual sample date. The model simulates the diameter and height increment of sampled trees for the length of time between their sampled date and the reporting year. The limit to the use of models for updating plot data is described in Appendix A.

The following growth models have been approved for the states listed.

State	Models Approved
California	▪ CACTOS: California Conifer Timber Output Simulator ▪ CRYPTOS: Cooperative Redwood Yield and Timber Output Simulator ▪ FVS: Forest Vegetation Simulator ▪ SPS: Stand Projection System ▪ FPS: Forest Projection System ▪ FREIGHTS: Forest Resource Inventory, Growth, and Harvest Tracking System ▪ CRYPTOS Emulator ▪ FORESEE

A Forest Owner may update inventory plot data for estimating diameter and height growth by incorporating data obtained from sample plots, as in a stand table projection. To qualify for this method:

- The Project Area shall be stratified into even-age management and uneven-age management.
- Diameter increment shall be based on the average annual increment of a minimum of 20 samples of radial growth for diameter increment for each 8” DBH (Diameter at Breast Height) class, beginning at 0 – 8” DBH for each management (even-age or uneven-age) type. The average annual increment shall be added for each year according to the plot’s sample date.

- Height increment shall be based on regression curves for each management type (even-age or uneven-age) developed from height measurements from the same trees the diameter increment data was obtained. The estimated height shall be determined using the regression estimators for the 'grown' diameters as described above.

Forest Owners incorporating this methodology are not eligible for extensions of plot life as described in Appendix A.

The Reserve may include additional models following approval of a state forestry authority (i.e. a person meeting the definition of Professional Forester who is employed by a state agency responsible for the oversight of forests) who will acknowledge in writing that the model:

- Has been peer reviewed in a process that: 1) primarily involved reviewers with necessary technical expertise (e.g. modeling specialists and relevant fields of biology, forestry, ecology, etc.), and 2) was open and rigorous
- Is parameterized for the specific conditions of the Project Area
- Limits use to the scope for which the model was developed and evaluated
- Is clearly documented with respect to the scope of the model, assumptions, known limitations, embedded hypotheses, assessment of uncertainties, and sources for equations, data sets, factors or parameters, etc.
- Underwent a sensitivity analysis to assess model behavior for the range of parameters for which the model is applied
- Is periodically reviewed (Prisley & Mortimer, 2004)

B.2 Using models to forecast carbon stocks

The use of simulation models is required for estimating a Forest Project's baseline carbon stocks. Models may also be required to forecast actual carbon stocks expected under the Forest Project (e.g. in conjunction with determining expected harvesting volumes or in updating forest carbon inventories).

Inventory information from Appendix A must be incorporated into the simulation models to project carbon stocks over time. If a model has the ability to convert biomass to carbon, it must include all the carbon pools required by this protocol.

Projected baseline or actual carbon stocks must be portrayed in a graph depicting time in the x-axis and carbon tonnes in the y-axis. Baseline carbon stocks must be projected forward from the date of the Forest Project's initiation. The graph should be supported with written characterizations that explain any annual changes in baseline carbon stocks over time. These characterizations must be consistent with the baseline analysis required in Section 6.

B.3 Modeling Requirements

A modeling plan must be prepared that addresses all required forecasting or updating of baseline and actual carbon stocks for the Forest Project. The modeling plan shall contain the following elements:

1. A description of all silviculture methods modeled. The description of each silviculture method will include:
    a. A description of the trees retained (by species groups if appropriate) at harvest
    b. The harvest frequency (years between harvests)
    c. Regeneration assumptions

2. A list of all legal constraints that affect management activities on the Project Area. This list must identify and describe the constraint and discuss the silviculture methods that will be modeled to ensure the constraint is respected.
3. A description of the site indexes used for each species and an explanation of the source of the site index values used.
4. A description of the model used and an explanation of how the model was calibrated for local use, if applicable.

Modeling outputs must include:

1. Periodic harvest, inventory, and growth estimates for the entire Project Area presented as total carbon tonnes and carbon tonnes per acre.
2. Harvest yield streams on modeled stands, averaged by silviculture method and constraints, which must include the period over which the harvest occurred and the estimated volume of wood removed.

Appendix C Estimating Carbon in Wood Products

Wood products may constitute a reservoir for storing carbon over the long term. Projects that increase wood product production can receive credit for the resulting incremental carbon storage. By the same token, projects that reduce wood product production must account for the incremental *reduction* in stored wood product carbon. As indicated in Section 7, the Reserve requires that GHG reductions and removals be effectively "permanent," meaning that sequestered carbon associated with GHG reductions and removals must remain stored for at least 100 years. Therefore, wood product carbon is estimated by calculating the average amount of carbon that is likely to remain stored in wood products over a 100-year period.

The processes described here are adapted from the 1605(b) methodology (U.S. Department of Energy, 2007) for accounting for the long-term storage of wood products. Please see Smith, Heath, Skog, & Birdsey (2006) for a more detailed description since the 1605(b) procedure was adapted from this publication.

Landfill carbon storage estimates are not included in the wood products accounting for purposes of quantifying creditable GHG reductions and removals. Calculation of landfill carbon storage is included in recognition that some sequestered carbon may remain in landfill storage after use. Due to uncertainty as to the fate of post-use wood products, the volume and duration of landfill storage over 100 years, as derived from the 1605(b) Table 1.9 (landfill), will not be included in the quantified GHG reductions and removals for Forest Projects, but must be reported separately.

Accounting for wood product carbon must be applied only to actual or baseline volumes of wood harvested from within the Project Area. Trees harvested outside of the Project Area are not part of the Forest Project and must be excluded from any calculations.

There are five steps required to determine carbon stored in wood products:

1. Determining the amount of carbon in harvested wood that is delivered to mills
2. Accounting for mill efficiencies
3. Estimating average carbon storage over 100 years in in-use wood products
4. Estimating average carbon storage over 100 years in wood products in landfills
5. Summing the results to determine total average carbon storage over 100 years

C.1 Determine the Amount of Carbon in Harvested Wood Delivered to Mills

The following steps must be followed to determine the amount of carbon in harvested wood:

1. Determine the amount of wood harvested that will be delivered to mills, by volume (cubic feet) or by green weight (lbs.), and by species.
    a. Baseline harvested wood volumes and species are derived from modeling a baseline harvesting scenario, following the requirements in Section 6
    b. Actual harvested wood volumes and species must be based on verified third-party scaling reports, where available. Where not available the Forest Owner must provide documentation to support the quantity of wood volume harvested
2. If a volume measurement is used, multiply the cubic foot volume by the appropriate wood density factor in Table C.1 (for projects located in the Pacific Southwest) or from

the USFS Wood Handbook (other regions).[15] This results in pounds of biomass with zero moisture content.

3. If a weight measurement is used, subtract the water weight based on the moisture content of the wood. This results in pounds of biomass with zero moisture content.
4. Sum the dry weights for each harvested species to get a total dry weight for all harvested wood.
5. Multiply this total value by 0.5 pounds of carbon/pound of wood to compute the total carbon weight.
6. Divide the total carbon weight by 2,240 pounds/metric tonne to convert to metric tonnes of carbon. This value is used in the next step, accounting for mill efficiencies.

Table C.1. Specific gravity and Wood Density of green softwoods and hardwoods by forest type for the Pacific Southwest from 1605(b) methodology (DOE, 2007, Table 1.4).

Forest Type	Specific Gravity of Softwoods	Specific Gravity of Hardwoods	Wood Density of Softwoods (lbs/ft^3)	Wood Density of Hardwoods (lbs/ft^3)
Mixed conifer	0.394	0.521	24.59	32.51
Douglas-fir	0.429	0.483	26.77	30.14
Fir-spruce-hemlock	0.372	0.510	23.21	31.82
Ponderosa pine	0.380	0.510	23.71	31.82
Redwood	0.376	0.449	23.46	28.02

C.2 Account for Mill Efficiencies

Multiply the total carbon weight (metric tones of carbon) derived in Section C.1 by the mill efficiency identified for the project's Assessment Area in Appendix F. This is the total carbon transferred into wood products. The remainder of the harvested carbon is considered to be immediately emitted to the atmosphere for accounting purposes in this protocol.

C.3 Estimate the Average Carbon Storage Over 100 Years in In-Use Wood Products

The amount of carbon that will remain stored in in-use wood products for at least 100 years depends on the rate at which wood products either decay or are sent to landfills. Decay rates depend on the type of wood product that is produced. Thus, in order to account for the decomposition of harvested wood over time, a decay rate is applied to wood products according to their product class. To better approximate the climate benefits of carbon storage, this protocol accounts for the average amount of carbon stored over 100 years. Thus, decay rates for each wood product class have been converted into "average storage factors" in Table C.2, below.

To determine the average carbon storage in in-use wood products over 100 years, the first step is to determine what percentage of a Project Area's harvest will end up in each wood product class (Columns A-G in Table C.2). This must be done by either:

1. Obtaining a verified report from the mill(s) where the Project Area's logs are sold indicating the product categories the mill(s) sold for the year in question; or

[15] The Wood Handbook (USFS, 1999) contains specific gravities for tree species in other regions. Multiply the specific gravity by the density of water (62.4 lbs/ft^3) to get wood density.

2. If a verified report cannot be obtained, looking up default wood product classes for the project's Assessment Area, as given in Appendix F.

If breakdowns for wood product classes are not available from either of these sources, classify all wood products as "miscellaneous."

Once the breakdown of in-use wood product categories is determined, use the worksheet in Table C.2 to estimate the average amount of carbon stored in in-use wood products over 100 years:

1. Assign a percentage to each product class (columns A-G) according to mill data or default values for the project.
2. Multiply the total carbon transferred into wood products (determined in Section C.2) by the percentages in each column and insert the resulting values into boxes 3A through 3G.
3. Multiply the values in 3A-3G by the 100-year average storage factor and insert the results into boxes 4A through 4G.
4. Use Equation C.1 to calculate the average carbon stored in in-use wood products over 100 years (in units of CO_2-equivalent metric tonnes).

Equation C.1.
$WP_{in\text{-}use}$ = ∑(Table C.2, Row 4) * 3.67

Where,

$WP_{in\text{-}use}$ = Average carbon stored in in-use wood products over 100 years

Table C.2. Worksheet to Estimate Long-Term Carbon Storage In In-Use Wood Products

	A	B	C	D	E	F	G
Wood Product Class	Softwood Lumber	Hardwood lumber	Softwood Plywood	Oriented Strandboard	Non Structural Panels	Miscellaneous Products	Paper
% in each class	(X%)	(X%)	(X%)	(X%)	(X%)	(X%)	(X%)
Metric tonnes C in each class	(3A)	(3B)	(3C)	(3D)	(3E)	(3F)	(3G)
100-year average storage factor (in-use)	0.470	0.262	0.490	0.585	0.387	0.189	0.078
Average C stored in in-use wood products (metric tonnes)	(4A)	(4B)	(4C)	(4D)	(4E)	(4F)	(4G)

C.4 Estimate the Average Carbon Storage Over 100 Years for Wood Products in Landfills

All projects must report wood product carbon in landfills. However, carbon in landfills will not be included in the wood products accounting for purposes of quantifying GHG reductions and removals. To determine the appropriate value for average landfill carbon storage, perform the following steps:

Step 1 – Determine expected net harvesting volumes relative to the baseline

Use Equation C.2 to estimate the total net amount of harvesting expected over the lifetime of the project.

Equation C.2.

$$HWP_{net} = \sum HWP_{baseline} - \sum HWP_{project}$$

Where,

HWP_{net} = Net harvesting volume over the life of the Forest Project (100 years)

$HWP_{baseline}$ = Expected harvesting volume expressed in CO_2-equivalent tonnes for each year of the baseline.

$HWP_{project}$ = Expected harvesting volume expressed in CO_2-equivalent tonnes for each year of the project.

Step 2 – Calculate the average carbon storage over 100 years for wood products in landfills

Use the worksheet in Table C.3 to estimate the average amount of wood product carbon stored in landfills over 100 years:

1. Assign a percentage to each product class (columns A-G) according to mill data or default values for the project (as determined in Section C.3).
2. Multiply the total carbon transferred into wood products (determined in Section C.2) by the percentages in each column and insert the resulting values into boxes 3A through 3G.
3. Multiply the values in 3A-3G by the 100-year average storage factor for landfill carbon and insert the results into boxes 4A through 4G.

Table C.3. Worksheet to Estimate Long-Term Carbon Storage in Wood Products in Landfills

	A	B	C	D	E	F	G
Wood Product Class	Softwood Lumber	Hardwood lumber	Softwood Plywood	Oriented Strandboard	Non Structural Panels	Miscellaneous Products	Paper
% in each class	(X%)	(X%)	(X%)	(X%)	(X%)	(X%)	(X%)
Metric tonnes C in each class	(3A)	(3B)	(3C)	(3D)	(3E)	(3F)	(3G)

100-year average storage factor (landfills)	0.294	0.407	0.283	0.231	0.339	0.446	0.173
Average C stored in landfills (metric tonnes)	(4A)	(4B)	(4C)	(4D)	(4E)	(4F)	(4G)

Step 3 – Determine the appropriate value to use for wood product carbon in landfills

Use Equation C.3 to determine the appropriate value for the average wood product carbon stored in landfills over 100 years (in units of CO_2-equivalent metric tonnes).

Equation C.3.

If $HWP_{net} > 0$, **then** $WP_{landfill} = \sum$(Table C.3, Row 4) * 3.67

Where,

HWP_{net} = Net harvesting volume over the life of the Forest Project (100 years) from Equation C.2.
$WP_{landfill}$ = Average carbon stored in wood products in landfills over 100 years

C.5 Determine Total Average Carbon Storage in Wood Products Over 100 Years

The total average carbon storage in wood products over 100 years for a given harvest volume (as determined in Section C.1) must be calculated and reported as follows (Equation C.4). The value derived for WP_{total} must be used for actual and baseline wood product carbon estimates ($AC_{wp,y}$ or $BC_{wp,y}$ in Equation 6.1) as appropriate, following the guidance in Section 6.

Equation C.4.
$$\mathbf{WP_{total} = WP_{in\text{-}use}}$$

Where,

WP_{total} = Average carbon stored
$WP_{in\text{-}use}$ = Average carbon stored in in-use wood products over 100 years

Appendix D Determination of a Forest Project's Reversal Risk Rating

Forest Owners must derive a reversal risk rating for their Forest Project using the worksheets in this section. The worksheets are designed to identify and quantify the specific types of risks that may lead to a reversal, based on project-specific factors.

This risk assessment must be updated every time the project undergoes a verification site visit. Therefore, a project's risk profile and its assessment are dynamic. Furthermore, estimated risk values and associated mitigation measures will be updated periodically by the Reserve as improvements in quantifying risks or changes in risks are determined. Any adjustments to the risk ratings will not affect prior contributions to the buffer pool.

Risks that may lead to reversals are classified into the categories identified in Table D.1.

Table D.1. Forest Project Risk Types

Risk Category	Risk Type	Description	How managed in this protocol
Financial	Financial Failure Leading to Bankruptcy	Financial failure can lead to bankruptcy and/or alternative management decisions to generate income that result in reversals through over-harvesting or conversion	Default Risk
Management	Illegal Harvesting	Loss of project stocks due to timber theft	Default by Area
	Conversion to Non-Forest Uses	Alternative land uses are exercised at project carbon expense	Default Risk
	Over-Harvesting	Exercising timber value at expense of project carbon	Default Risk
Social	Social Risks	Changing government policies, regulations, and general economic conditions	Default Risk
Natural Disturbance	Wildfire	Loss of project carbon through wildfire	Risk and Risk-Mitigation Worksheet
	Disease/Insects	Loss of project carbon through disease and/or insects	Default Risk
	Other Episodic Catastrophic Events	Loss of project carbon from wind, snow and ice, or flooding events	Default Risk

D.1 Financial Risk

Financial failure of an organization resulting in bankruptcy can lead to dissolution of agreements and forest management activities to recover losses that result in reversals. Projects that employ a Qualified Conservation Easement or Qualified Deed Restriction, or that occur on public lands, are at a lower risk than projects with a PIA alone.

Table D.2. Financial Risk Identification

Applies to all projects		
Identification of Risk	**Impact of Risk on Removal Enhancements**	
Default Financial Risk	**PIA only**	**PIA combined with Qualified Conservation Easement or Qualified Deed Restriction or on public lands**
	5%	1%

D.2 Management Risk

Management failure is the risk of management activities that directly or indirectly could lead to a reversal. Projects that employ a conservation easement or deed restriction, or that occur on public lands, are exempt from this risk category.

Management Risk I – Illegal Removals of Forest Biomass

Illegal logging occurs when biomass is removed either by trespass or outside of a planned set of management activities that are controlled by regulation. Illegal logging is exacerbated by lack of controls and enforcement activities.

Table D.3. Risk of Illegal Removals of Forest Biomass

Applies to all projects	
Identification of Risk	**Impact of Risk on Removal Enhancements**
United States Default Harvesting Risk	0%
Enter value that reflects project's illegal forest biomass removals risk:	

Management Risk II – Conversion of Project Area to Alternative Land Uses

High values for development of housing and/or agriculture may compete with timber and carbon values and lead to a change in land use that affects carbon stocks. The risk of conversion of any Project Area to other non-forest uses is related to the probability of alternative uses, which are affected by many variables, including population growth, topography, proximity to provisions and metropolitan areas, availability of water and power, and quality of access to the Project Area.

Table D.4. Risk of Conversion to Alternative Land Use

Applies to all projects	
Identification of Risk	**Impact of Risk on Removal Enhancements**
With Qualified Conservation Easement or Qualified Deed Restriction that explicitly encumbers all development rights	0%
Without Qualified Conservation Easement or Qualified Deed Restriction	2%

Management Risk III – Over-Harvesting

Favorable timber values, among other reasons, may motivate some project managers to realize timber values at the expense of managing carbon stocks for which CRTs have been credited. Additionally, reversals can occur as the result of harvest associated with fuels treatments.

Table D.5. Risk of Over-Harvesting

Applies to all projects	
Identification of Risk	**Impact of Risk on Removal Enhancements**
With Qualified Conservation Easement or Qualified Deed Restriction that explicitly encumbers timber harvesting associated with project stocks	0%
Without Qualified Conservation Easement or Qualified Deed Restriction	2%

D.3 Social Risk

Social risks exist due to changing government policies, regulations, and general economic conditions. The risks of social or political actions leading to reversals are low, but could be significant.

Table D.6. Social Risk Identification

Applies to all projects	
Identification of Risk	**Impact of Risk on Removal Enhancements**
United States Default Social Risk	2%
Enter value that reflects project's social risk:	

D.4 Natural Disturbance Risk

Natural disturbances can pose a significant risk to the permanency GHG reductions and removals. Natural disturbance risks are only partially controllable by management activities.

Management activities that improve resiliency to wildfire, insects, and disease can reduce these risks. Management activities that shift harvesting practices from live sequestering trees to trees that have succumbed to natural disturbances reduce or negate the reversal depending on the size and location of the disturbance.

Natural Disturbance Risk I – Wildfire

A wildfire has the potential to cause significant reversals, especially in certain carbon pools. These risks can be reduced by certain techniques including reducing surface fuel loads, removing ladder fuels, adding fuel breaks, and reducing stand density. However, these techniques cannot reduce emission risk to zero because all landowners will not undertake fuel treatments, nor can they prevent wildfire from occurring.

Table D.7. Natural Disturbance Risk I – Wildfire

Applies to all projects	
Identification of Risk	**Impact of Risk on Removal Enhancements**
For the Assessment Area the project is located in, determine long-term fire risk potential from fire history perimeter maps (at least 30 years) – enter rate as an annualized percentage.*	X%
If fuel treatments have been implemented for the Project Area, reduce the value above by the appropriate % as indicated below.**	(X%)*Y%

* If the project proponent has more property specific fire data of at least 30 years in duration that may be used in lieu of the regional Assessment Area values.
** Depending on the level of fuel treatments the Y% is set as follows: high level of fuel treatments = 50%, medium level of fuel treatments = 66.3%, low level of fuel treatments = 82.6%, no fuel treatments = 100%.

Natural Disturbance Risk II - Disease or Insect Outbreak

A disease or insect outbreak has the potential to cause a reversal, especially in certain carbon pools.

Table D.8. Natural Disturbance Risk II – Disease or Insect Outbreak

Applies to all projects	
Identification of Risk	**Impact of Risk on Removal Enhancements**
Default Risk Contribution from Disease or Insect Outbreak	3%

Natural Disturbance Risk III - Other Episodic Catastrophic Events

A major wind-throw event (hurricane, tornado, high wind event) has the potential to cause a reversal, especially in certain carbon pools.

Table D.9. Natural Disturbance Risk III – Other Episodic Catastrophic Events.

Applies to all projects

Identification of Risk	Impact of Risk on Removal Enhancements
Default Risk Contribution from Other Catastrophic Events	3%

D.5 Summarizing the Risk Analysis and Contribution to Buffer Pool

Use the table below to summarize the Forest Project's reversal risk rating. As indicated above, projects that employ a conservation easement or deed restriction, or that occur on public lands, are exempt from certain risk categories. Such Qualified Conservation Easements and Qualified Deed Restrictions must clearly identify the goals and objectives of the Forest Project according to the terms of this protocol.

Table D.10. Project Contribution to the Buffer Pool Based on Risk.

Risk Category	Contribution from Risk Descriptions Above		
	Source	PIA Only	PIA and Qualified Conservation Easement and/or a Qualified Deed Restriction and/or Public Ownership
Financial Failure	Default Risk -Remedies for reversals addressed in PIA	5%	1%
Illegal Forest Biomass Removal	From worksheet	-	-
Conversion	Default Risk - Remedies for reversals addressed in PIA	2%	0%
Over-Harvesting	Default Risk - Remedies for reversals addressed in PIA	2%	0%
Social	Default Risk	2%	2%
Wildfire	Calculated Risk from worksheet	X%	X%
Disease or Insect Outbreak	Calculated Risk from worksheet	3%	2%
Other Catastrophic Events	Calculated Risk from worksheet	3%	2%

Completing the Risk Rating Analysis:

The project's reversal risk rating is calculated as follows:

$$100\% - \begin{pmatrix} (1 - FinancialFailure\%) \times (1 - IllegalForestBiomassRemoval\%) \times (1 - Conversion\%) \\ \times (1 - OverHarvesting\%) \times (1 - SocialRisk\%) \times (1 - Wildfire\%) \times (1 - Disease/InsectOutbreak\%) \\ \times (1 - OtherCatastrophicEvents\%) \end{pmatrix}$$

Appendix E Reforestation Project Eligibility

This appendix presents a standardized approach to determine whether reforestation activities on lands that have undergone a Significant Disturbance are likely to be "business as usual" – and therefore not eligible for registration with the Reserve – based on the net present value for the timber expected to be produced from reforestation. A reforestation project is considered "business as usual" if the net present value for expected timber is $0 or more according to standard assumptions underlying Table E.1.

To determine whether a reforestation project is eligible, perform the following steps:

1. Identify whether site preparation costs[16] are High or Low:
    a. Site preparation costs are High if:
        i. Competing species management (including mechanical removal and/or use of herbicides) has been or will be conducted on 50% or more of the Project Area; or
        ii. Soil ripping has occurred on more than 50% of the Project Area.
    b. Site preparation costs are Low for all other projects.
2. Identify the value of harvested products (High, Medium, Low, or Very Low) corresponding to the project's Assessment Area, from the lookup table in Appendix F.
3. Identify the standard Rotation Age for the project's Assessment Area, from the lookup table in Appendix F.
4. Identify the site class category for the Project Area. The category must be consistent with the stated site productivity in the project's submission form to the Reserve. Projects with mixed site classes must round to the nearest site class category based on a weighted average.
    a. Site Classes I and II are classified as 'Higher'
    b. Site Classes III, IV, and V are classified as 'Lower'
5. Determine whether the project is "eligible" or "not eligible" according to the identified site preparation costs, value of harvested products, rotation age, and site class, as indicated in Table E.1.

[16] All projects are assumed to have similar costs related to the cost of seedlings and planting; site preparation costs, however, can vary depending on circumstances.

Table E.1. Determination of Reforestation Project Eligibility

Site Preparation Costs	Value of Harvested Products	Rotation Age (Years)	Site Class	Eligibility	Scenario #
High Site Preparation	High	<60	Higher	Not Eligible	1
			Lower	Not Eligible	2
		>=60	Higher	Eligible	3
			Lower	Eligible	4
	Medium	<50	Higher	Not Eligible	5
			Lower	Not Eligible	6
		50 - 59	Higher	Not Eligible	7
			Lower	Eligible	8
		>=60	Higher	Eligible	9
			Lower	Eligible	10
	Low	<30	Higher	Not Eligible	11
			Lower	Eligible	12
		>=30	Higher	Eligible	13
			Lower	Eligible	14
	Very Low	>=30	Higher	Eligible	15
			Lower	Eligible	16
Low Site Preparation	High	<60	Higher	Not Eligible	17
			Lower	Not Eligible	18
		60 - 69	Higher	Not Eligible	19
			Lower	Eligible	20
		>=70	Higher	Eligible	21
			Lower	Eligible	22
	Medium	<50	Higher	Not Eligible	23
			Lower	Not Eligible	24
		50 - 59	Higher	Not Eligible	25
			Lower	Eligible	26
		>=60	Higher	Eligible	27
			Lower	Eligible	28
	Low	< 30	Higher	Not Eligible	29
			Lower	Not Eligible	30
		30 - 49	Higher	Not Eligible	31
			Lower	Eligible	32
		>=50	Higher	Eligible	33
			Lower	Eligible	34
	Very Low	>=30	Higher	Eligible	35
			Lower	Eligible	36
		<30	Higher	Not Eligible	37
			Lower	Not Eligible	38

Appendix F California Assessment Areas

Ecosection - refer to the associated map to determine which ecosection the project is in.	Forest Community / Assessment Area	Major Associated Species	Common Practice Indicator - Carbon Tonnes per Acre in Live Trees*	Composition of Native Species Threshold (maximum percentage of any one species) for Natural Forest Management Table 3.1	Fire Risk Rating	Rotation Age	Value of Harvest	Native Species Reference	Mill Efficiency	Default Wood Product Classes
Eastside	**California mixed conifer**	**canyon live oak, mountain hemlock, lodgepole pine, pacific madrone, ponderosa pine, red alder, bigleaf maple, tanoak, western white pine, Jeffrey pine, red fir, white fir, sugar pine, black oak**	27	80%	tbd	60	Medium Low	Jepson Flora Project, which may be accessed on-line at: http://ucjeps.berkeley.edu/jepsonflora/. Species Diversity determined by Wildlife Habitat Relationships	67.5%	100% softwood lumber
	Mixed hardwoods	**western juniper, pinyon pine, Oregon white oak, valley oak, aspen, interior live oak, black oak, cottonwood, willow, gray pine, knobcone pine, blue oak**	5	80%	tbd	70	Low		67.5%	N/A
Sierra Nevada-Southern Cascades	**California mixed conifer**	**white fir, western white pine, tanoak, red fir, red alder, ponderosa pine, pacific madrone, mountain hemlock, lodgepole pine, Jeffrey pine, canyon live oak, bigleaf maple, sugar pine, black oak**	39	70%	tbd	60	Medium Low		67.5%	100% softwood lumber

Ecosection - refer to the associated map to determine which ecosection the project is in.	Forest Community / Assessment Area	Major Associated Species	Common Practice Indicator - Carbon Tonnes per Acre in Live Trees*	Composition of Native Species Threshold (maximum percentage of any one species) for Natural Forest Management Table 3.1	Fire Risk Rating	Rotation Age	Value of Harvest	Native Species Reference	Mill Efficiency	Default Wood Product Classes
	Mixed hardwoods	**western juniper, pinyon pine, Oregon white oak, valley oak, aspen, interior live oak, black oak, cottonwood, willow, gray pine, knobcone pine, blue oak**	22	60%	tbd	70	Low		67.5%	N/A
Sierra Nevada and North CA Foothills	**California mixed conifer**	**white fir, western white pine, tanoak, red fir, red alder, ponderosa pine, pacific madrone, mountain hemlock, lodgepole pine, Jeffrey pine, canyon live oak, bigleaf maple**	22	80%	tbd	60	Medium Low		67.5%	100% softwood lumber
	Mixed hardwoods	**Oregon white oak, valley oak, interior live oak, black oak, cottonwood, willow, gray pine, blue oak**	14	60%	tbd	70	Low		67.5%	N/A
Klamath Mountains	**California mixed conifer**	**white fir, western white pine, tanoak, red fir, red alder, ponderosa pine, pacific madrone, mountain hemlock, lodgepole pine, Jeffrey pine, canyon live oak, bigleaf maple, Douglas-fir, sugar pine, black oak**	41	70%	tbd	60	Medium Low		67.5%	100% softwood lumber

Ecosection - refer to the associated map to determine which ecosection the project is in.	Forest Community / Assessment Area	Major Associated Species	Common Practice Indicator - Carbon Tonnes per Acre in Live Trees*	Composition of Native Species Threshold (maximum percentage of any one species) for Natural Forest Management Table 3.1	Fire Risk Rating	Rotation Age	Value of Harvest	Native Species Reference	Mill Efficiency	Default Wood Product Classes
	Mixed hardwoods	**Oregon white oak, valley oak, aspen, interior live oak, black oak, cottonwood, willow, gray pine, knobcone pine, blue oak**	14	60%	tbd	70	Low		67.5%	N/A
Northern California Coast Ranges	**California mixed conifer**	**ponderosa pine, Douglas-fir, sugar pine, red alder, tanoak, black oak**	45	70%	tbd	60	Medium Low		67.5%	100% softwood lumber
	Mixed hardwoods	**Oregon white oak, valley oak, aspen, interior live oak, black oak, cottonwood, willow, gray pine, knobcone pine, blue oak, California laurel**	30	60%	tbd	70	Low		67.5%	N/A
Northern California Coast	**Mixed hardwoods**	**Oregon white oak, valley oak, interior live oak, black oak, cottonwood, willow, gray pine, blue oak, California laurel**	45	60%	tbd	70	Low		67.5%	N/A
	Redwood	**tanoak, Sitka spruce, redwood, red alder, pacific madrone, Douglas-fir, western hemlock**	72	80%	tbd	60	Medium High		67.5%	100% softwood lumber
Central California Coast and Ranges	**Mixed hardwoods**	**Oregon white oak, valley oak, interior live oak, black oak, cottonwood, willow, gray pine, blue oak, California laurel**	19	60%	tbd	70	Low		67.5%	N/A
	Redwood	**tanoak, redwood, red alder, pacific madrone, Douglas-fir, coast live oak**	61	80%	tbd	70	Medium High		67.5%	100% softwood lumber

Ecosection - refer to the associated map to determine which ecosection the project is in.	Forest Community / Assessment Area	Major Associated Species	Common Practice Indicator - Carbon Tonnes per Acre in Live Trees*	Composition of Native Species Threshold (maximum percentage of any one species) for Natural Forest Management Table 3.1	Fire Risk Rating	Rotation Age	Value of Harvest	Native Species Reference	Mill Efficiency	Default Wood Product Classes
Central California Coast Mountains and Valleys	**California mixed conifer**	**tanoak, red alder, ponderosa pine, pacific madrone, mountain hemlock, lodgepole pine, Jeffrey pine, canyon live oak, bigleaf maple**	25	70%	tbd	60	70%		67.5%	100% softwood lumber
	Mixed hardwoods	**valley oak, interior live oak, black oak, cottonwood, willow, gray pine, blue oak, California laurel**	20	60%	tbd	50	Low		67.5%	N/A
*Estimated Carbon on forest land, private ownerships only, California 2001-2007. Data includes above and below ground portions of the live trees.										