Forest Project Protocol
Summary of Proposed Revisions

April 2017

In addition to minor editorial changes, the U.S. Forest Project Protocol (FPP) Version 4.0 incorporates the following significant changes from Version 3.3.

- **Restructured Forest Project Aggregation guidance (Section 2.3)** Forest Project Aggregation guidance has been removed from the FPP and relocated to an external document available on the Reserve website, as was done in previous versions of the FPP. This improves the readability of the protocol guidelines by placing highly detailed and specific guidance in a separate place.
- **Updated Location eligibility (Section 3.1)** This section has been revised to allow for Reforestation and Avoided Conversion projects in U.S. Territories, as those project types do not rely on the availability of FIA data.
- **Updated Permanence guidance (Section 3.5)** This section has been renamed from Minimum Time Commitment to Permanence for consistency with other Reserve protocols. Guidance has been added regarding project termination to detail an option for terminating project activities on a portion of the project area, to acknowledge and conservatively allow for revisions to project boundaries over the life of a project.
- **Updated Regulatory Compliance guidance (Section 3.8)** This section has been updated to clarify likely instances in which violations will be considered "material", with an increased focus on those violations directly linked to the carbon project.
- **Updated Sustainable Harvesting and Natural Forest Management Practices guidance (Section 3.9)** This section has been reformatted for clarity, particularly regarding the metrics used for assessing conformance. The substantive requirements contained in this section have not changed.
- **Updated even aged management restrictions (Section 3.9.2)** This section has been revised to change the even aged management restriction to allow for expanded harvesting area commensurate with increasing harvest retention. The intent is to provide flexibility to area harvesting limits when harvest retention is increased.
- **Updated guidance for identifying Project Area (Section 4)** Guidance has been included in this section for utilizing Landfire to identify Assessment Areas. This section has also been modified to include guidelines regarding the accuracy of Project Area Acreage (Section 4.1). Landfire is a third party (government) product and its use is an unbiased approach to identifying Assessment Area requirements.

- **Addition of project configuration and limitations criteria (Section 4.1)** Guidelines have been provided to ensure that Project Areas are representative of forest management so that the baseline approach is reasonable for the project. This section is designed to replace what was previously known as the "Logical Management Unit" or LMU analysis. All references to LMU have been removed from the project quantification and baseline modeling. The intent of the LMU analysis was to reduce the likelihood of projects receiving credits based on "selection bias", or positioning their project boundaries deliberately for favorable crediting. In its place, the protocol has established a requirement that contiguous watershed areas (as described in the protocol) be included in the project.
- **Exclusion of RF-3, RF-4, and RF-5 (Section 5.1)** Standing dead wood (RF-3), lying dead wood (RF-4), and litter and duff (RF-5) have been excluded from the GHG Assessment Boundary. The motivation for this is to focus on the primary effect of a reforestation project (increasing standing live carbon stocks). Since many reforestation projects take place following a natural disturbance, declines in these pools are commensurate with natural baseline conditions and are unrelated to the project's primary effect. Their inclusion can potentially create reversals through no fault of the forest owner.
- **Updated Modeling Financial Constraints option 2 guidance (Section 6.2.1)** Clarification has been added to confirm that past harvest activities within the Project Area may be used to demonstrate the financial feasibility of the baseline harvest regime.
- **Updated Standardized Unadjusted Baseline calculation guidance (Section 6.2.1)** Common Practice has been updated to include all onsite carbon stocks, so the corresponding quantification guidance has been updated accordingly. Logical Management Unit provisions have also been removed based on the guidance referenced above in Section 4.1, as previously described.
- **Updated guidance for estimating baseline onsite carbon stocks for public land Improved Forest Management projects (Section 6.2.2)** A new methodology has been incorporated for setting the baseline for IFM projects taking place on public lands.
- **Updated secondary effects and leakage accounting (Section 6.2.6)** Leakage quantification previously utilized a standard 20% discount. Leakage in the protocol has always taken a long-term perspective to shifting harvest patterns based on project activities. The updated approach improves the estimate of long-term leakage based on predicted harvest practices in the project activity.
- **Updated timeline for verifying unavoidable reversals (Section 7.3.1)** The deadline for submitting a verified estimate of onsite carbon stocks following an unavoidable reversal has been extended from one year to two years, to allow for a more accurate accounting of delayed mortality following a reversal event.
- **Clarified deadline for submitting annual monitoring report (Section 8.2)** This section has been updated for consistency with a Reserve policy memo to state that annual monitoring reports are due within 12 months of the reporting period end date.
- **Reporting period duration and cycle (Section 8.3)** This section has been updated for consistency with the Reserve Program Manual.
- **Updated stopping rules for sequential sampling (Section 9.3.5.1)** This section has been updated to provide separate stopping rules for diameter and height measurements, and plot-based CO_2e/acre measurements. The approach is intended to focus verification

efforts on areas where a demonstration of alignment between Forest Owner and verifier has not been met, improving the overall efficiency of verification.

- **Included reference to the Reserve's Standardized Inventory Methodology and Climate Action Reserve Inventory Tool (CARIT) (Section 9.3.5.2)** The Reserve has published a Standardized Inventory Methodology and computer inventory tool (CARIT) that are intended to reduce the cost of project implementation and verification for those who choose to use these tools. Both the inventory methodology and the associated computer tool are undergoing validation. Once completed, they do not need to be verified for subsequent projects. They have been acknowledged in the FPP as approved tools.
- **Updated measurement guidance for verifiers (Section 9.3.5.3)** Guidance has been included for determining in/out trees. Verification of sampling practices in the field is intended to ensure project developers apply the sampling methodology correctly and accurately. The guidance provides some limited flexibility for verifiers to evaluate the trees as they existed at the time of measurement. Some of the trees on plots may have grown beyond parameters that existed in the sampling methodology at the time of measurement. This is consistent with the guidance provided in the Mexico Forest Project Protocol and is intended to reduce ambiguity and improve efficiency in verification services.
- **Updated minimum number of passing plots for sequential sampling (Sections 9.3.5.4 and 9.3.5.5)** The minimum number of passing plots for sequential sampling has been revised for stratified and non-stratified inventories. In most cases, this will reduce the number of plots required to pass sequential sampling, while improving consistency with the intent of the sequential sampling test. The earlier version of sequential sampling added elements of rigor that are not part of the sequential sampling procedures described in the literature. When those measures were included, the sequential sampling application to forest measurement testing was new and the additional measures were intended to ensure an ultra-high level of conservatism to verification. The updated approach maintains a high level of rigor in that a stated minimum number of plots must be evaluated prior to successful verification outcomes, but modifies the requirement for a stated number of continuous successful plots to be included, which is consistent with the literature. Additionally, internal analysis indicated that once the stated minimum number of verified plots has occurred and is successful, ongoing verification efforts did not change the ultimate outcome of the verification opinion. In other words, the additional testing is unwarranted and adds unnecessary costs to verification.
- **Added definition of commercial harvesting (Section 10)** Definition of commercial harvesting has been added to help clarify the intent of the sustainable harvesting requirements.
- **Update of the Assessment Area Data File and inclusion of new Assessment Areas** A new Supersection has been added (Hawaii). The Assessment Area Data File has been updated to include new common practice values reflective of the latest available FIA data. Site class distinctions have been removed so that each Assessment Area has one common practice value. Information not required for project implementation (such as board feet and basal area data) have been removed. Default Harvested Wood Product classes have been added for Hawaii, and updated for Alaska. The Mill Efficiency reference document has been incorporated into the Assessment Area Data File, and mill efficiencies have been added for Hawaii.

- **Update to Quantification Guidance:** Projects can exclude up to 5% of their plots from being selected for verification oversite due to harvest that occurred in the past reporting period. This condition is allowed for the plots for one year only. It is intended to address the challenges of synchronizing plot updates with verification activities.

Quantification Guidance for Use with Forest Carbon Projects

June 28, 2017

This document provides guidance for quantifying a forest project's onsite carbon stocks and carbon in harvested wood products, both for purposes of estimating a project's baseline as well as providing ongoing estimates of onsite project carbon stocks throughout the project life.

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1 Reporting Requirements for Forest Carbon Pools

Onsite forest carbon pools are broadly grouped into living biomass, dead biomass, and soils. Living biomass includes biomass in live trees and shrubs and herbaceous understory (live non-tree biomass). Onsite dead biomass includes biomass in dead trees, lying dead wood, and litter. Offsite dead biomass includes harvested wood products.

For standardized reporting, all estimates of forest carbon stocks must be provided in terms of metric tons (tonnes) of CO_2-equivalent (CO_2e) on a project and a per acre basis. Unless otherwise required in the referenced biomass equations, the following conversion formulae shall be used:

<table>
<tr><th>Base Unit</th><th>Conversion</th><th rowspan="5">=</th><th>Final Unit</th></tr>
<tr><td>Biomass</td><td>0.5 x biomass</td><td>Carbon</td></tr>
<tr><td>Carbon</td><td>3.67 x carbon</td><td>CO_2e</td></tr>
<tr><td>Tons</td><td>0.90718474 x tons</td><td>Metric tons or tonnes (t)</td></tr>
<tr><td>Hectares</td><td>0.404686 x hectares</td><td>Acres</td></tr>
</table>

Reporting requirements vary for each of the carbon pools. The estimates for the pools that are derived from sampling must meet the quality standards described later in this document. Table 1.1 displays the reporting requirements for each of the carbon pools.

Table 1.1. Reserve Requirements for Carbon Pool Categories and Determination of Value for Pool

<table>
<tr><th>Category</th><th>Carbon Pool</th><th>Improved Forest Management</th><th>Reforestation</th><th>Avoided Conversion</th></tr>
<tr><td rowspan="2">Living Biomass</td><td>Live Trees</td><td colspan="3">Required for project reporting</td></tr>
<tr><td>Shrubs and Herbaceous Understory</td><td>Not allowed for project reporting</td><td>Any removals as part of site preparation must be quantified</td><td>Not allowed for project reporting</td></tr>
<tr><td rowspan="5">Onsite Dead Biomass</td><td rowspan="2">Standing Dead Trees</td><td colspan="3">Required for adherence to Natural Forest Management criteria</td></tr>
<tr><td>Required for project reporting</td><td>Required for project reporting, excluding pre-existing dead and dying trees</td><td>Required for project reporting</td></tr>
<tr><td rowspan="2">Lying Dead Wood</td><td colspan="3">Required for adherence to Natural Forest Management criteria</td></tr>
<tr><td colspan="3">Not allowed for project reporting</td></tr>
<tr><td>Litter</td><td colspan="3">Not allowed for project reporting</td></tr>
<tr><td rowspan="2">Soil</td><td rowspan="2">Soil</td><td colspan="3">Required for emissions reporting associated with management activities</td></tr>
<tr><td colspan="3">Optional for reporting of project benefits in Avoided Conversion projects only</td></tr>
<tr><td>Offsite Dead Biomass</td><td>Harvested Wood Products</td><td colspan="3">Required for project reporting</td></tr>
</table>

2 Guidance for Estimating Carbon in Forest Carbon Pools

This section describes requirements for the development of values for the forest carbon pools described in Table 1.1. Project Operators must include an inventory methodology in the Project Design Document. The inventory methodology must include the required provisions identified in this section.

2.1 Inventory Methodologies

All inventory methodologies must be based on randomized or systematic sampling and include the minimum quality parameters described in this section for each carbon pool. Inventory methodologies must describe the process for locating sample plots. Sample plot locations may be monumented in such a way to assist in relocating them for quantification and verification purposes. Plot monument strategies that incorporate Global Positioning Systems (GPS) along with additional navigational strategies at close range to plot centers (that direct verifiers to the precise plot location) that are resistant to weather, wildlife, and other environmental factors, can substantially reduce verification costs. Project Operators are advised to consider the verification guidance (Section 10 of the Forest Project Protocol) associated with verification of sampled carbon pools (in particular, the sequential sampling guidance) prior to settling on a strategy to monument plot locations.

To increase the efficiency of both project development by Project Operators and verification by verifiers, the Reserve has developed a Standardized Inventory Methodology that Project Operators may optionally use to determine how to collect sample data. The Standardized Inventory Methodology is available on the FPP webpage and draws on observations about the standards and methodologies that have performed well for registered forest carbon projects. Designed in consultation with experienced project developers, verifiers and forest mensuration experts, it was created in consideration of a variety of factors, such as being suitable for use in a variety of forest conditions, achieving consistent results in consecutive plot measurements, and minimizing ambiguity in interpretation of conditions in the field.

Additionally, the Standardized Inventory Methodology was developed to be consistent with the Climate Action Reserve Inventory Tool (CARIT), an inventory management computer application that Project Operators may also optionally use to manage and update their forest inventories. CARIT is available on the FPP webpage at no cost. With CARIT, Project Operators will be able to manage forest inventories, calculate timber and carbon stocking, and update inventories for growth, disturbances (including harvests), and updated sampling data. The volume and biomass equations required by the FPP are already programmed into CARIT, eliminating the need for Project Operators to apply such equations on their own and ensure they are correctly applied. Additionally, CARIT generates reports that are tailored specifically to the reporting requirements of the FPP.

The use of the Standardized Inventory Methodology does not obligate a Project Operator to use CARIT, nor does the use of CARIT obligate a Project Operator to use the Standardized Inventory Methodology. However, CARIT will only function properly if certain inventory standards are followed. For example, only fixed area plots may be used—variable radius plots are not allowed.

2.2 Updating Forest Inventories

Forest inventories are always in flux due to forest growth, harvest, and natural disturbances. Therefore, inventories of carbon pools must either be updated or re-measured at a frequency commensurate with the anticipated or actual changes in the specific carbon pools so that sample plots and forest stratification reflect current conditions. Project Operators must report their estimated carbon stocks on an annual basis. Since it is infeasible to immediately re-measure all plots following forest growth and disturbances that affect plot measurements, acceptable strategies for updating project inventory estimates are described in this section.

2.2.1 Updating for Forest Growth

Updating plot data for forest growth can be accomplished through the use of growth models or stand table projections that mimic the diameter and height increment of trees in the inventory database. Any plot data that are updated to reflect current conditions with the use of predicted increments of height and diameter data will be used during site visit verifications to compare against verifier's field measurements using the sequential sampling techniques described in the verification section of the Forest Project Protocol. This provision ensures that plot measurements and update processes are within accuracy thresholds.

2.2.2 Updating for Disturbances (Including Harvest)

Inventory estimates must be updated annually for any disturbance (including harvest disturbance) that results in an estimated reduction to the reported carbon pools of 0.5 percent or more. However, given that it may be infeasible to re-measure all plots following a disturbance, up to 5 percent of the total inventory plots used to derive the inventory estimate can be excluded at any one time. Only plots in disturbed areas may be excluded, and no plot can be excluded for a period of time greater than one reporting period. Plots that are geographically situated in areas that experienced forest cover class-changing harvests and/or natural disturbances in the previous year must be excluded from the inventory analysis until the plots are updated with re-measured data from field visits, subject to the 5 percent limit on excluded plots outlined above. If the inventory is stratified, the area that has been disturbed can simply be re-stratified with a stratum that reflects the post-disturbance forest condition, following the stratification rules developed for the project. Any plots that existed in the disturbed area must be removed from the set of plots used to estimate the stratum average unless, and until, the affected plots are re-measured. Verification of stratified inventories must ensure that the area disturbed is accurately characterized in the inventory GIS system and that the assigned stratum reflects the forest condition.

For non-stratified inventories, an estimated tree list that represents the post-disturbance condition of the forest must be assigned to any plots affected by the disturbance. The tree list must be carefully selected to not overstate the carbon pools present. Site verification of post-disturbance plots will evaluate whether the tree list assigned is appropriate for the post-disturbance condition. No more than 10 percent of the project's area may be represented through estimated plots without increased verification scrutiny during a site visit. Specifically, where more than 10 percent of the project's area is based on estimated tree lists assigned to plots, verification using sequential sampling techniques shall include all plots (including estimated plots) in the sequential sampling comparison between Project Operator estimates and verifier estimates.

Plots that are estimated shall not be used in the calculations for sampling error. Estimates from sampled pools must meet a minimum confidence standard of +/- 20 percent at the 90 percent confidence interval. It is acceptable to calculate the descriptive statistics, including confidence intervals, using plot data that have been updated to a current date. Discounts for uncertainty are applied to project estimates when confidence standards are below +/- 5 percent at the 90 percent confidence interval. This is described in greater detail below.

2.3 Requirements for Estimating Carbon in Standing Live and Dead Trees

It is required that both standing live and standing dead trees[1] be sampled. It is acceptable, but not required, to combine standing live and dead trees during sampling such that descriptive statistics, including confidence statistics, address the combined pools. Whether combined or not, tree data must be coded so that mean estimates can be interpreted independently for standing live and standing dead pools to allow monitoring of standing dead trees with respect to requirements in the Natural Forest Management section (Section 3.9) of the Forest Project Protocol.

Inventory methodologies must include a description of how the sampled data will be archived and the analytical tools that will be included in the analysis of carbon stocks. The tree lists that are developed from inventory sampling and used to expand inventory estimates to the project level must be available for verification review. It is acceptable for the tree list to be presented and reviewed in an electronic format, such as in a database or spreadsheet application. Table 2.1 displays the requirements that all project inventory methodologies must include for standing live and dead trees.

Table 2.1. Requirements for Sampling Standing Live and Standing Dead Trees

Species	1. All trees sampled must include a species identifier. The inventory methodology must provide a crosswalk between any codes used to identify a species and the species name the codes represent. 2. Since all trees contain carbon, the inventory methodology must indicate that the sample methodology will include all species present within the project area.
Diameter at Breast Height (DBH) Measurements	1. Inventory estimates must include all trees 5 inches DBH and larger. It is acceptable that inventory methodologies include trees with DBH less than 5 inches. 2. The location of the measurement of DBH must follow U.S. FIA sampling guidelines (can be found on the Forest Project Protocol webpage). 3. Measurement precision must be no greater than the nearest inch.
Height	1. Inventory methodologies must describe whether all trees on sample plots are measured for height or whether a subset of the sample plot heights is measured and regression estimators are developed for unmeasured heights. 2. Inventory methodology must describe whether height measurements describe the tree's total height or some other top height measurement (regression estimators, or published form equations, may also be used to estimate top heights from a partial height or vice versa). Where regression estimators are used for tree heights, the inventory methodology must describe the populations from which the regression estimators were acquired. 3. The sampling precision for tree heights (when measured) must be stated in the inventory methodology. Stated acceptable precision for measured heights not to be greater than +/- 10 feet. 4. The inventory methodology must include a description of the maximum angle accepted for measuring tree heights. The stated maximum acceptable slope to the measured height shall not exceed 120 percent.

[1] In the case of reforestation projects, standing dead trees is not always an included SSR. See Section 5.1 of the FPP for more information.

Weight (Plot Area and Forest Strata)	1. All methodologies must describe the sample plot areas used to determine which trees are included for measurement. 2. All tree lists must include a field(s) that displays the weighting of each sampled tree in order to expand the sampled tree to a per acre value. 3. Where inventories are stratified, the governing rules for stratification and stratification methodology must be described. The process for updating forest strata must be described. 4. Where inventories are stratified, stratum areas must be provided at verification with maps and tabular outputs.
Status	1. Each sampled tree must be identified as live or dead. 2. Dead trees must be coded with the decay status so density adjustments can be made. Decay class descriptions and density adjustments are provided below.
Biomass Equations	1. All projects must calculate the biomass in each tree using the biomass equations provided by the Reserve (can be found on the Forest Project Protocol webpage). 2. The project's inventory methodology must include a list of the equations and cite the version of the Reserve's equation file from which they were copied. 3. The CARIT tool (optional) includes approved biomass equations to reduce the burden of verification.
Deductions for Missing Biomass	1. Both live and dead trees may have cavities, broken tops or other deformities that reduce the biomass in the trees. Therefore, the inventory methodology must include a description of how deductions are estimated to account for missing biomass. The Reserve has provided guidance below that is acceptable. Alternative methods that address deductions for missing biomass are subject to approval by the Reserve.

Sampling methodologies and measurement standards should be consistent throughout the duration of the forest project. If new sampling methodologies are incorporated during the project life, they must be approved by the Reserve. Sampling methodologies and measurement standards will be evaluated for their statistical validity. Additionally, uncertainties in estimates associated with modifications to sampling methodologies may require reconciliation to project data and/or baseline estimates and shall be conducted at the Reserve's sole discretion. The application of a revised sampling methodology can only occur as part of a site visit verification.

2.4 Use of Regression Equations

It is acceptable to develop carbon inventories using regression estimators to estimate tree heights. Project Operators must keep in mind that plots or (sub) populations will be randomly selected for verification and that regression estimators should be used where a high level of certainty can be developed from the estimators. Failure to do so will result in increased effort and cost to meet the standards of verification.

2.5 Forest Vegetation Stratification

Stratification is not required, but it may simplify verification and possibly lower the costs of verification. Where forest vegetation is stratified, inventory methodologies must describe the guidelines used for stratification. Traditional stratification decisions are usually based on species composition, forest stem size (DBH or height), and density. It is important that the stratification be relevant to sampling forest carbon. The minimum polygon size to which the stratification guidelines apply must be included in the methodology. A map of current forest strata must be included in the Project Design Document. The methodology must also include the process guidelines for updating forest strata for disturbance and growth events.

2.6 Quantification of Carbon in Live Trees from Project Data

All projects must use the appropriate biomass equations for the assessment areas the project is located in. The required biomass equations are found on the Reserve's Forest Project Protocol webpage. The calculation of CO_2e for each tree must be conducted in a manner that provides project estimates for:

- Whole tree biomass (roots, stump, bark, bole, top, and branches). Whole tree estimates are used to provide project totals and estimates of emissions associated with harvest activities.
- Bole biomass. The bole must be calculated when the bole portion of harvested trees are delivered to manufacturing facilities for processing. It is used as the basis for determining carbon persisting in long-term wood products.
- Aboveground portion (stump, bark, bole, top, and branches) used to compare project data to common practice statistics for Improved Forest Management projects.
- Bole portion, for inclusion in calculations of carbon stored in harvested wood products.

Projects outside of California, Oregon, Washington, Alaska, and Hawaii use estimators for non-bole portions of the tree referred to as the Component Ratio Method (CRM). The CRM must be used to compute the various portions of the tree mentioned above. Guidance for the use of the CRM is provided in the biomass equations section of the Reserve's Forest Project Protocol webpage.

Projects in California, Oregon, Washington, Alaska, and Hawaii must use the biomass equations provided on the Reserve's Forest Project Protocol webpage to calculate the aboveground portion of the trees. The Cairn's equation (Cairns, Brown, Helmer, & Baumgardner, 1997) must be used to calculate CO_2e in the below-ground portion of the trees. The Cairn's equation is:

$$BBD = \exp[-0.7747 + 0.8836 \times \ln(ABD)]$$

Where,

			Units
BBD	=	Belowground biomass density of standing live trees	tonnes/hectare
ABD	=	Aboveground biomass density of standing live trees	tonnes/hectare

This estimate must be converted from biomass in tonnes per hectare to CO_2e in tonnes per acre using the conversions identified earlier in this guidance.

2.7 Adjustments to Standing Live and Standing Dead Trees for Missing Volume and Decay

Both standing dead trees and standing live trees may be missing portions of the tree as the result of physical and biological disturbances. Tree biomass needs to be adjusted for missing parts to produce an improved estimate of the tree's biomass. Calculating CO_2e in standing dead trees raises additional challenges since they may be in stages of decay such that density equations in standard biomass equations for live trees do not provide an accurate estimate. The guidance in this section provides a standardized method to account for biomass adjustments.

The first step is to estimate the gross biomass in the tree as if it were whole, using the biomass equations (the first step in the biomass and carbon calculations) provided on the Reserve's Forest Project Protocol webpage. The tree's biomass is then adjusted based on the tree's 'net' biomass and adjusted density estimates for standing dead trees. To standardize, the tree is divided into four parts: top, middle, bottom (visually estimating the original disposition of the aboveground portion of the tree when it was alive and vigorous), and the below-ground portion. The below-ground portion must be calculated as it would for a normal, healthy tree, using the Cairn's equation where the regional biomass equations are used instead of the CRM. It is assumed that the below-ground portion is intact and complete. The standardized percentages assumed to be in each portion of the tree are shown in Table 2.2.

Table 2.2. Assumed Percentages of Biomass in Each Portion of the Tree

Tree Portion	Percent of Tree Biomass
Top 1/3	10%
Middle 1/3	30%
Bottom 1/3	60%

An ocular estimate is made of the portion remaining in each section of the tree during field sampling. Deductions from gross volume are made for anything that reduces the tree's gross biomass, including breakage and cavities. The percentage remaining in each third is then summed to calculate the net biomass remaining in the tree.

The tree's density must be adjusted to account for the varying states of decay in the remaining portion of the tree. Because standing dead wood does not have the same density as a live tree, a density reduction must be applied. Standing dead wood may fall into five decay classes, which must be recorded during the field sampling. The five decay classes, described in Table 2.3, are qualitative, based on the physical characteristics of the dead tree (USDA 2007, Woundenberg et al., 2010).

Table 2.3. Decay Classes

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

The density identified for each species in the biomass equations posted on the Reserve's Forest Project Protocol webpage must be modified for decay classes 2 to 5 using the reduction factors displayed in Table 2.4,[2] which are multiplied by the densities provided in the biomass equations.

Table 2.4. Average Density Reduction Factors for Standing Dead Wood for Hardwoods and Softwoods by Decay Class

Softwoods		Hardwoods	
Decay Class	**Reduction Factor**	**Decay Class**	**Reduction Factor**
2	1.0	2	0.8
3	0.92	3	0.54
4	0.55	4	0.43
5	0.29	5	0.22

An example of field data that has all of the required elements for calculating the standing dead tree's CO_2e is shown in Table 2.5.

Table 2.5. Example: Data Attributes Needed to Calculate CO_2e in Standing Dead Trees

Tree Number	Species (type)	Status	DBH (inches)	Height* (feet)	Percent Remaining			Decay Class
					Top 1/3 of Tree	Middle 1/3 of Tree	Bottom 1/3 of Tree	
1	Hardwood	Dead	16	95	0%	50%	100%	3

*Estimated height prior to death

The density of the tree must be adjusted based on its decay class. The first step is to calculate the tree's biomass as if the tree were a normal tree to determine the tree's gross biomass. Net biomass is determined by multiplying the gross biomass of the tree by the reduction factor displayed in Table 2.4. An example is provided in Table 2.6.

Table 2.6. Example: Adjusting Biomass Calculation for Decay Using Density Adjustment Factors

Tree Gross Biomass	Density Reduction Based on Decay	Net Biomass
(tonnes CO_2e) (Assumed)	(from Table 2.4 for a hardwood with a decay class '3')	(tonnes CO_2e) (Assuming tree is whole)
0.100	0.54	0.054

As an example of the application of the biomass deductions for missing sections of the tree, using the data from Table 2.5 above, a tree (assuming normal form) with a net biomass of 0.054 CO_2e tonnes would be further adjusted to a net biomass for the missing portions of the tree as shown in Table 2.7.

[2] Harmon et al. (2011). Differences between standing and downed dead tree wood density reduction factors: A comparison across decay classes and tree species. Res. Pap. NRS-15. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 40 p.

Table 2.7. Example: Calculating Net Biomass in a Tree

Tree Portion	Percent of Tree Biomass	Gross Biomass	Percent Remaining in Tree	Net Biomass
	(from Table 2.2)	(tonnes CO_2e) Percent of tree biomass **x** tree biomass adjusted for density (Table 2.6)	(from example in Table 2.5)	(tonnes CO_2e) Percent remaining in tree **x** gross biomass
Top 1/3	10%	10% **x** 0.054 **=** 0.0054	0%	0.00000
Middle 1/3	30%	30% **x** 0.054 **=** 0.0162	50%	0.0081
Bottom 1/3	60%	60% **x** 0.054 **=** 0.0324	100%	0.0324
	Total Biomass		200	0.0405

2.8 Requirements for Estimating Lying Dead Wood Carbon

All projects must either maintain an inventory of lying dead wood for the project area or monitor harvested areas according to the guidance in this section to ensure the project meets the conditions identified in Section 3.9.2 (Natural Forest Management) of the Forest Project Protocol. Lying dead wood is not eligible for crediting due to the high variability associated with estimating lying dead wood, resulting in estimates with unacceptable levels of uncertainty for crediting. Project Operators are required to include the status of lying dead wood with each monitoring report.

Project Operators that choose to meet the monitoring requirement by maintaining an inventory of lying dead wood must meet the following requirements:

1. Inventory plots or transects used to provide the lying dead wood estimate must be no older than 12 years.
2. Data collected for lying dead wood must include the estimated species, adequate data to estimate volume, and decay class, as defined by Table 2.8 below, to estimate the density of the piece of lying dead wood to determine biomass.
3. The sampling methodology must be included in the Project Design Document. The Reserve is not prescriptive with regards to the sampling design, other than adhering to general statistical principles of randomness. Fixed area plots and line transects, among other sampling methodologies, are acceptable.
4. The inventory sampling confidence in the estimate of lying dead wood must be at +/- 30 percent at 1 standard error.

Project Operators that choose to meet the monitoring requirement through monitoring of harvested areas must meet the following requirements:

1. A harvested area is any area where commercial removal of forest vegetation has occurred.
2. A map of all areas harvested during the last reporting period must be submitted with the annual monitoring report and must include the harvest date.
3. All harvested areas must be monitored within one year of the harvest date.

4. Fixed area strips shall be randomly located on compass bearings chosen by the Project Operator (but maintained consistent within each harvest area). A recommended width of the fixed area strip is 66 feet (1 chain), which will require monitoring in each of the 33 foot areas on either side of the center line. Ten square chains equals one acre. Project Operators can determine the width of the strip that best suits the vegetation conditions present in the harvested area.
5. A map shall be produced that displays the location of the fixed area strips on the harvested areas. The width of the strip shall be documented for each strip.
6. The minimum area monitored shall be 5 percent of each harvested area.
7. Data collected within the fixed area strip must include the estimated length of the piece of lying dead wood, the average diameter of the lying dead wood, the estimated species, and the decay class as defined by Table 2.8 below.

Lying dead wood density must be adjusted to account for the state of decay. Because lying dead wood does not have the same density as a live tree, a density reduction must be applied. Lying dead wood may fall into five decay classes, which must be recorded during the field sampling. The five decay classes are qualitative based on the physical characteristics of the dead tree (USDA 2007, Woundenberg et al., 2010).

Table 2.8. Decay Class Descriptions of Lying Dead Wood

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

The density identified for each species in the biomass equations posted on the Reserve's website must be modified for decay classes 2 to 5 using the reduction factors displayed in Table 2.9,[3] which are multiplied by the densities provided in the biomass equations.

[3] Harmon et al. (2011). Differences between standing and downed dead tree wood density reduction factors: A comparison across decay classes and tree species. Res. Pap. NRS-15. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 40 p.

Table 2.9. Average Density Reduction Factors for Lying Dead Wood for Hardwoods and Softwoods by Decay Class

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

An adjusted density coefficient for the downed logs is calculated by multiplying the density coefficient provided with the biomass equations on the Reserve's Forest Project Protocol webpage by the reduction value in the table above. The adjusted density value is multiplied by the volume estimate in the lying dead wood to determine the biomass.

2.9 Requirements for Estimating Soil Carbon Emissions and Soil Carbon Quantification for Avoided Conversion Projects

All projects must estimate the soil carbon emissions associated with project management practices. Avoided Conversion projects are eligible (optional) to report the baseline soil carbon emissions the project activity is avoiding. This section provides guidance for estimating soil CO_2e within the project boundaries, and quantifying emissions associated with project activities.

No direct sampling of soil carbon is required for projects that are reporting soil carbon emissions only as part of project management practices. Rather, the estimate of emissions is based on soil carbon estimates from United States Geological Survey (USGS) data for project sites and comparing the data to standardized guidance to assess emissions based on management activities.

For Avoided Conversion projects, the project benefit is determined by comparing the project soil carbon estimate (from sampling) to the standardized estimate of emissions associated with the activity. Currently, only Avoided Conversion projects that demonstrate a risk of conversion to agriculture (grazing not included) are eligible to report soil carbon benefits associated with the avoided conversion activity. Conversion risks to housing, development, golf courses, etc., are not currently eligible.

To summarize, Table 2.10 provides the two different approaches to quantifying soil carbon benefits and/or emissions.

Table 2.10. Soil Carbon Quantification Methods by Project Type

Project Description	Project Type Identification	Method to Estimate Project Soil Carbon (CO_2e) Stocks	Method to Estimate Project Effects on Soil Carbon (CO_2e)
Project will provide benefits by avoiding soil carbon emissions associated with conversion to agriculture (Avoided Conversion)	1	Soil carbon sampling required at project initiation	Initial avoided conversion effects estimated through standardized guidance
			Follow guidance in Step 7
		Follow guidance in Steps 1, 4, 5, and 6	Ongoing project effects estimated through default estimates of soil carbon emissions
			Follow guidance in Steps 1, 4, 5, and 6
Project is reporting management-related emissions	2	Use of USGS data	Project effects estimated through default estimates of soil carbon emissions
		Follow guidance in Steps 1, 2, 3, and 6	Follow guidance in Step 7

2.9.1 Developing an Estimate of Soil CO_2e within the Project Boundaries

Step 1: Identify Soil Orders Present Within Project (**Project Types 1 and 2**)

Project Operators must determine the soil orders present in their project area and the area each soil order represents. Where Natural Resource Conservation Service (NRCS) soil data is available on the NRCS website (http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx), projects must use this data. Where NRCS data is either unavailable or believed to be in error at the project site, Project Operators may present the soil orders and area represented by each order with an official letter from a local NRCS representative stating that the portrayal of the soil orders by the Project Operator is accurate. The letter must state why existing data is either absent on the NRCS website or why the data is not accurate.

On the NRCS website mentioned above, users must create an Area of Interest (AOI), using the website tools, that approximates the project boundaries. To determine the soil order, users select the soil reports tab, select land classifications, and select “Taxonomic Classification of Soils”. This report provides a taxonomic classification of each of the soils in the AOI. The last four letters of the soil descriptions correspond to the soil order. For example, a soil classified as Xerochrepts is in the Inceptisol order. Table 2.11 below displays the soil orders associated with the last four letters in the soil descriptions.

Table 2.11. Soil Orders

Soil Order	Last Four Letters in Soil Description
Alfisol	-alfs
Andisol	-ands
Inceptisol	-epts
Mollisol	-olls
Spodosol	-ods
Ultisol	-ults
Histosol	-ists

Step 2: Obtain Soil Organic Matter Values (**Project Type 2**)

Select the tab entitled 'Soil Properties and Qualities', then select 'Soil Organic Matter' and within the advanced options, select 'Weighted Average'. For the aggregation method, select 'Higher' as the tie break rule, and designate '0-30 cm' for the soil depth. Next, click 'View Ratings' to review the organic matter percentage for each soil type in the AOI. Convert the number from the rating to decimal percent by dividing by 100.

Step 3: Obtain the Soil Bulk Density Values (**Project Type 2**)

Soil bulk density estimates are determined by first selecting the 'Soil Properties and Qualities' tab, the 'Bulk Density' tab next, followed by the 'On-third Bar'. Specify the 'Weighted Average' method and soil depth (0-30 cm, unless otherwise noted). Select 'View Ratings. The ratings will provide bulk density values for each soil type in the AOI. If the bulk density values are not available in the database, determine whether the soil orders are qualified as sandy, loamy, or clay using the 'Surface Texture' value in the Soil Properties and Qualities tab and then apply default values of 1.2 g/cm^3 for clay soils, 1.6 g/cm^3 for sand soils, and 1.4 g/cm^3 for loam soils.

Step 4: Sample for Soil Organic Matter (**Project Type 1**)

Soil carbon estimates are based on sampling soil organic matter for the project. Materials needed include:

- Rubber mallet
- Square spade (for removing organic material from core site)
- Soil probe
- Compass
- Trowel and/or sturdy knife (for cleaning soil off outside service of probe)
- Plastic bags (1 bag for each soil core)
- Marking pen
- Measuring tools (meters and centimeters)

Step 4a: Identifying the Plot Locations

Plots must be located randomly or systematically with a random start in each of the soil orders that occur on the project site. An adequate number of plots is needed to ensure the overall estimate of soil carbon meets or exceeds the minimum confidence levels stated in the Forest Project Protocol (+/- 20 percent at 90 percent confidence interval). It is acceptable to use the same, or a subset of, plot locations as used for biomass sampling, so long each soil order is sampled and the overall soil carbon estimate achieves the confidence standards stated above.

Step 4b: Identify Four Random Locations at Each Plot and Extract Soil Organic Matter Samples

4b-i: Select a random number by glancing at a watch's second hand (or digital version). Multiply this number by six to derive a compass bearing to use for the soil sample locations. Following the determined compass bearing, measure 10 meters from the plot center and establish each of the four soil sample locations. Minimal spatial adjustments (less than 2 meters) can be made to avoid rocks and roots from impacting the ability to sample. If obstacles cannot be avoided within 2 meters, an additional sample location must be selected using the method described above.

4b-ii: For each sample location, insert a soil core probe (minimum diameter, ½ inch) into the soil at the sample location to a depth of 30 cm. A rubber mallet may be used to facilitate penetration. If the probe will not penetrate to the required depth, the probe must be removed, wiped free of soil, and inserted in an alternate location with a 2 meter radius from the sample location. If repeated efforts result in difficulties achieving full penetration, an additional sample location must be chosen as described in Step 4b-i. If full penetration is not achieved within two efforts to locate a satisfactory sampling location, the sample must be taken from the initial sample location and the depth recorded.

4b-iii: Soil must be extracted carefully from the probe to avoid losing any of the soil collected. Should any soil be lost, the sample must be rejected and a new sample location selected as described above. The extracted soil is placed in a sealable plastic bag. Label the bag with the plot number followed by the letter “SOM”, indicating the sample is a “soil organic matter” sample (not a bulk density sample).

4b-iv: The soil organic matter samples must be sent to a laboratory with expertise in analyzing soil carbon and physical properties within 106 hours of the acquisition of the samples from the plot sites. The laboratory must receive instructions that the samples are to be heated to over 1000 degrees Celsius. This heat will burn off the carbon and a detector is to be used to measure the amount of carbon dioxide produced and reported as a percent of the volume sampled.

Step 5: Sample for Bulk Density (**Project Type 1**)

Sampling for soil bulk density must be conducted on the project site. Materials needed include:

- Rubber mallet
- Piece of wooden 2x4 approximately 1 to 2 feet in length
- Square spade
- Soil core/ring with known volume
- Trowel and/or sturdy knife
- Plastic bags (1 bag for each soil pit)
- Marking pen
- Measuring tools (meters and centimeters)

Step 5a: One random location 4 meters from each plot center must be selected for soil data collection to dig a soil pit to a depth of at least 30 cm^3. The measure of depth must be below the organic layer (branches, leaves, moss, etc.). The sides of the pit can be made straight using the trowel or the study knife. Random selection is achieved through the use of the second hand method described in Step 4b-i. Adjustments to the location of the pit can be made using the adjustments allowed for difficulties associated with inserting soil probes described in 4b-ii.

Step 5b: Two samples will be taken from the soil pit. The sample is taken by centering the soil ring at a depth of 7.5 cm and the second is taken by centering the ring at a depth of 22.5 cm. The ring is inserted perpendicular to the pit face. The location of each insertion must be into undisturbed soil, as occurs during the process of extracting the soil rings. The soil pit can be expanded to ensure that undisturbed soil is sampled.

5b-i: For each of the samples the sharp end of the ring is pushed in, without twisting, as far as possible with the hands.

5b-ii: The piece of wood is placed over the ring and gently hammered evenly into the soil. If strong resistance is encountered, an alternate location may be found within the pit, or a new pit located using the guidance described above.

5b-iii: Using the trowel or sturdy knife, soil is removed around the outside of the ring to allow for extraction of the ring without losing soil. The surfaces of the ring should be cleaned and cut flush to the surface of the ring. Small losses during extraction and cleaning (up to 2 cm^3) can be restored by filling the void with soil from the pit site and smoothing. Samples must be rejected if soil losses from the ring occurring during extraction and cleaning are greater than 2 cm^3.

5b-iv: The soil from both ring samples is placed in one sealable plastic bag and labeled with BD and the plot number.

5b-v: The bulk density samples must be sent to laboratory with expertise in analyzing soil carbon and physical properties within 106 hours of the acquisition of the samples from the plot sites. Bulk density instructions sent with the samples shall describe that the samples are to be dried at 105 degrees centigrade for at least 48 hours and that all portions of the sample are to be retained (including rocks). The laboratory shall present the results of the analysis of bulk density estimates as g/cm^3, displaying dry weight over total sample volume.

Step 6: Calculate the Total Soil CO_2 per Acre (**Project Types 1 and 2**)

Use Equation 2.1 (below) to calculate the soil CO_2 per acre.

Equation 2.1. Soil CO_2e per Acre

Soil CO_2e	=	Organic Matter Value (Steps 2 or 4) **x** 0.58 (Conversion of Organic Matter to Carbon) **x** Bulk Density Value (Steps 3 or 5) **x** Soil Depth Sampled (30 cm) **x** 40,468,564.224 (Conversion of 1 cm^2 to 1 acre) **x** 10^{-6} (Conversion of 1 gram to 1 metric ton) **x** 3.67 (Conversion of Carbon to CO_2)

An example is provided in Table 2.12 below.

Table 2.12. Example: Calculation for Total CO_2 per Acre

Organic Matter from Steps 2 or 4		0.05
Conversion of Organic Matter to Carbon	x	0.58
Bulk Density (g/cm^3) from Steps 3 or 5	x	1.2
Soil Depth Sampled (30 cm)	x	30
Conversion of 1 cm^2 to 1 acre (1 acre = 40,468,564.224 cm^2)	x	40,468,564.224
Conversion of 1 gram to 1 metric ton Carbon	x	0.000001
Conversion of 1 metric ton Carbon to 1 metric ton CO_2	x	3.67
Estimated Metric Tons CO_2 per Acre	=	155.05

Step 7: Quantify the Project Effects on Soil CO_2e (**Project Types 1 and 2**)

Project effects are calculated using the standardized guidance below. Avoided Conversion projects must use the standardized guidance for purposes of estimating project benefits. Soil carbon emissions resulting from management activities are determined where the activity, or set of activities, leads to a net loss of soil carbon across the entire project. Net emissions can occur across the project area in a sustainably managed forest where emissions from management activities are not restored during the rest, or growth, cycle of the stand. The default values provided are derived from scientific literature and address the high-end estimates of net emissions associated with management activities, except in the case of conversion where it is more conservative to underestimate the emissions associated with the avoided activity. The background documentation[4] for the default values is found on the Reserve's Forest Protocol Version 3.3 webpage under References.

Default emission values are provided as percentages for each soil order, based on harvesting intensity, site preparation intensity, and the frequency of disturbance. Project Operators must report their soil carbon emissions by grouping the total acres in each permutation, or class of soil order, harvesting intensity, site preparation intensity, and frequency of disturbance, rather than reporting on an individual stand basis. An example of reporting classes of management activities is provided below, following the descriptions of the management activities.

Net carbon emissions are estimated as the difference between carbon stocks (CO_2e) in the soil prior to the management activity and the carbon stocks (CO_2e) in the soil immediately prior to the subsequent harvest event for each harvested stand. Index values are provided for both harvesting intensity and site preparation intensity that, when combined, classify the harvesting intensity for the stand. The index value for harvesting intensity is derived from both the amount of biomass removed during harvest and the soil disturbance associated with the biomass removal. The index value for site preparation is based on the amount of soil disturbance associated with site preparation activities.

For each stand harvested in a given reporting year, Project Operators must determine the harvesting intensity using the guidance below. For Avoided Conversion projects, the guidance is used below to assist in determining baseline conditions and applied to the project rather than individual stands. First, the index value is determined for the stand based on the amount of biomass removed during harvest, based on guidance in Table 2.13.

Step 7a: Harvesting Intensity

The harvesting intensity value is calculated using a factor for the amount of biomass removed and the amount of soil disturbance that occurs removing the biomass. Both values are added together to calculate the harvesting intensity. The value for disturbance related to biomass removal is determined using Table 2.13 below:

[4] Gershenson, Alex. Establishing a Standardized Method to Account for Soil Carbon Emissions Associated with Management Activities.

Table 2.13. Determination of Biomass Removal Index

Biomass Affected by Harvest		
Percentage Pre-Harvest Aboveground Biomass Removed	**Silviculture Activities Generally Associated with Level of Biomass Removed**	**Biomass Removal Index**
< 10%	Sanitation Salvage	0
10 – 50%	Selection, Thinning	0
51 – 80%	Rotation harvest with biomass remaining in tree tops, seed/shelterwood and/or retained trees	1
> 80%	Rotation harvest with whole tree harvesting and little retention	2
Not a Silvicultural Activity – There is no intent to follow up with efforts to regenerate forested conditions		
100%	Conversion – only relevant to assessment of Avoided Conversion baseline	10

Step 7b: Soil Disturbance from Harvesting Activities

The second value considered for determining the harvest intensity is based on the level of soil disturbance associated with biomass removal. Soil disturbance within the harvested stands boundary may be the result of skidding logs, tree falling, and harvesting equipment. The disturbance may be extensive or minimized, depending on site-specific conditions and care taken during harvesting operations. The soil disturbance index is based on the amount of mineral soil (below the organic layer, including litter and duff) exposed due to harvest activities. The determination of the amount of mineral soil disturbance is from ocular inspection of harvested stands. Table 2.14 below is used to determine the soil disturbance index from harvesting.

Table 2.14. Determination of Soil Disturbance Index

Percent of Mineral Soil Exposed during Harvest	Soil Disturbance Index
< 5%	0
5 - 20%	2
20 - 40%	3
40 - 60%	4
> 60%	5

Step 7c: Determining the Harvesting Intensity Class

The values for the biomass removal index and the soil disturbance index are summed together to determine the harvesting intensity class, displayed below in Table 2.15.

Table 2.15. Harvesting Intensity Classes based on Summing the Biomass Removal and Soil Disturbance Indexes

Harvesting Intensity Classes	
Harvesting Intensity Class	**Sum of Biomass Removal and Soil Disturbance Indexes**
Light to Medium	< 3
High	3 - 4
Very High	5 - 7
Conversion	> 7

Step 7d: Determining Site Preparation Classes

For each stand harvested, the Project Operator must determine the site preparation index using the guidance in Table 2.16.

Table 2.16. Site Preparation Classes and Descriptions of Management Activities

Site Preparation	
Site Preparation Class	**Description**
Very Light	Less than 5% surface area disturbance of soil below litter and duff due to ripping, grading, raking, etc.
Light	5% to 24% surface area disturbance below litter and duff due to ripping, grading, raking, etc.
Medium	25% to 59% surface area disturbance below litter and duff due to ripping, grading, raking, etc.
Heavy	60% to 100% surface area disturbance below litter and duff due to ripping, grading, raking, etc.
Conversion	Soils cleared of trees, stumps and other forest vegetation and prepared for agriculture, grazing, and/or development. No return to forest vegetation.

Step 7e: Determining the Frequency of Disturbance

The frequency of disturbance is determined as the time between harvest activities associated with the specific silviculture event that is being evaluated for soil carbon emissions. The value for frequency of disturbance is assigned to each harvested stand based on the amount of pre-harvest basal area remaining in the post-harvest stand. The standardization of these values is based on protocol requirements that onsite forest carbon stocks be maintained or increased and the minimum rotation age in even-aged management silviculture effectively set at 50 years.

Table 2.17. Frequency of Disturbance Classification

Frequency of Disturbance	Harvest Retention	Assumed Years to Next Harvest
Short	> 75% of pre-harvest basal area	Up to 15 years
Medium	51 – 75% of pre-harvest basal area	16 to 35 years
Long	26 – 50% of pre-harvest basal area	36 to 50 years
Very Long	< 26% or pre-harvest basal area	> 51 years

Step 7f: Determining Emissions Associated with Management Activities

For each class of harvested stands, or stands that have received site treatment, a value is determined for each combination of harvest intensity, frequency of disturbance, site preparation, and soil order. A percent value is derived from Table 2.18 below based on the combination of the various classes.

Table 2.18. Estimated Net Carbon Loss

Harvesting Intensity	Frequency of Disturbance	Site Treatment	Estimated Net Carbon Loss by Soil Order						
			Alfisol	***Andisol***	***Inceptisol***	***Mollisol***	***Spodosol***	***Ultisol***	***Histosol***
Light to Medium	Short	Very Light	0%	0%	0%	0%	0%	0%	80%
	Medium		0%	0%	0%	0%	0%	0%	80%
	Long		0%	0%	0%	0%	0%	0%	80%
	Very Long		0%	0%	0%	0%	0%	0%	80%
High	Short	Very Light	Conifers 0% Hardwoods 20%	0%	8%	0%	10%	9%	80%
		Light	Conifers 5% Hardwoods 20%	5%	8%	5%	10%	9%	80%
		Medium	Conifers 10% Hardwoods 20%	10%	10%	10%	20%	11%	80%
		Heavy	Conifers and Hardwoods 20%	20%	20%	20%	41%	22%	80%
	Medium	Very Light	Conifers 6% Hardwoods 20%	0%	0%	0%	33%	24%	80%
		Light	Conifers 6% Hardwoods 20%	5%	5%	5%	33%	24%	80%
		Medium	Conifers 10% Hardwoods 20%	10%	10%	10%	33%	24%	80%
		Heavy	Conifers and Hardwoods 20%	20%	20%	20%	41%	24%	80%
	Long	Very Light	Conifers 0% Hardwoods 20%	0%	0%	0%	31%	0%	80%
		Light	Conifers 5% Hardwoods 20%	5%	5%	5%	31%	5%	80%
		Medium	Conifers 10% Hardwoods 20%	10%	10%	10%	31%	11%	80%
		Heavy	Conifers and Hardwoods 20%	20%	20%	20%	41%	22%	80%
	Very Long	Very Light	0%	0%	0%	0%	5%	0%	80%
		Light	0%	0%	0%	0%	10%	5%	80%
		Medium	0%	0%	0%	0%	20%	11%	80%
		Heavy	0%	0%	0%	0%	41%	22%	80%

Very High	Short	Very Light	Conifers 6% Hardwoods 20%	6%	28%	6%	1%	6%	80%
		Light	Conifers 6% Hardwoods 20%	6%	28%	6%	10%	6%	80%
		Medium	Conifers 10% Hardwoods 20%	10%	28%	10%	20%	11%	80%
		Heavy	Conifers and Hardwoods 20%	20%	53%	20%	41%	22%	80%
	Medium	Very Light	Conifers 6% Hardwoods 20%	6%	6%	6%	0%	5%	80%
		Light	Conifers 6% Hardwoods 20%	6%	6%	6%	10%	6%	80%
		Medium	Conifers 6% Hardwoods 20%	10%	10%	10%	20%	11%	80%
		Heavy	Conifers and Hardwoods 20%	20%	20%	20%	41%	22%	80%
	Long	Very Light	Conifers 6% Hardwoods 20%	5%	6%	6%	0%	6%	80%
		Light	Conifers 6% Hardwoods 20%	6%	6%	6%	10%	6%	80%
		Medium	Conifers 6% Hardwoods 20%	10%	10%	10%	20%	11%	80%
		Heavy	Conifers and Hardwoods 20%	20%	20%	20%	41%	22%	80%
	Very Long	Very Light	Conifers 6% Hardwoods 6%	6%	6%	6%	0%	6%	80%
		Light	Conifers 6% Hardwoods 6%	6%	6%	6%	10%	6%	80%
		Medium	Conifers 6% Hardwoods 6%	6%	6%	6%	20%	6%	80%
		Heavy	Conifers 6% Hardwoods 6%	6%	6%	6%	41%	6%	80%
Conversion	Conversion	Agriculture	30%	30%	30%	30%	30%	30%	80%
		Residential - Commercial	0%	0%	0%	0%	0%	0%	80%

This percentage is multiplied by the soil carbon (CO_2e) estimate on a per acre basis and multiplied by the stand's acres to determine the emissions to report for each stand. The stand emissions are summed to determine the soil carbon emissions (CO_2e) reported annually. An example of the calculation is provided in Table 2.19 below.

Table 2.19. Example: Calculations for Annual Soil Carbon Reporting

Reporting Year				**2012**					
A	B	C	D	E	F	G	H	I	J
Stand ID	Soil Order	Soil Carbon (CO_2e) Tonnes per Acre	Acres	Stand Soil Carbon (CO_2e) Tonnes	Harvesting Intensity	Disturbance Frequency	Site Preparation	Estimated Soil Carbon Loss %	Stand Soil Carbon Loss (CO_2e) Tonnes
	From Step 1	From Step 6		D **x** C	From Step 7a	From Step 7e	From Step 7d	Table 2.18	I **x** E
1	Alfisol	85	595	50,575	Very High	Very Long	Heavy	6%	3,035
2	Alfisol	85	683	58,055	Light - Medium	Short	Very Light	0%	-
3	Alfisol	85	2,232	189,720	High	Long	Light	5%	9,486
Sum of Soil Carbon Emissions (CO_2e) Tonnes									**12,521**

2.10 Onsite Carbon Stocks Affected by Site Preparation Activities with Reforestation Projects

The removal of standing dead trees, brush, and downed logs associated with Reforestation Projects may constitute a significant quantity of emissions compared to the project benefits in the short term. Therefore, Reforestation Projects must estimate the biological emissions associated with site preparation activities prior to planting trees.

For carbon pools that will be affected by site preparation, an inventory of the pools that will be affected must be conducted prior to any site preparation activities. For those carbon pools that are affected by site preparation, Project Operators must provide an estimate of initial carbon stocks using one of the following alternatives:

- Measuring carbon stocks using 20 randomly placed sample plots located in the portion of the project area containing the greatest amount of biomass in the pool or pools that will be affected. The portion of the area sampled shall be calculated. The estimate derived on a per acre basis shall be applied to the balance of the project area.
- Stratifying (classifying) the project area into similar densities and measuring stocks within the affected carbon pools using 20 randomly located sample plots per density class.
- Measuring the affected carbon stocks based on a systematic grid system across the project area.

2.11 Total Onsite Carbon Stocks and Calculating the Confidence Deduction

Annual reporting is conducted by summing the carbon stocks present at the end of the reporting period in all of the relevant carbon sources, sinks, and reservoirs for the project. Certain reported pools are sampled and the mean estimate is used for annual reporting. The number reported for the sampled pools is adjusted based on the confidence in the estimate of the carbon. The sampling error is calculated for each of the sampled pools at the 90 percent confidence interval and subsequently calculated as a percentage of the mean, using the following steps:

Step 1: Calculate the mean and the standard error of the inventory estimate (for each pool or combined pools where applicable, such as with standing live and dead wood).

Step 2: Multiply the standard error by 1.645.

Step 3: Divide the result in Step 2 by the total inventory estimate and multiply by 100. This establishes the sampling error (expressed as a percentage of the mean inventory estimate from field sampling) for a 90 percent confidence interval.

Table 2.20. Example: Summing All Onsite Carbon Stocks and Calculating the Confidence Deduction

Carbon Pool	Source of Data	Project Type(s)	Required/ Optional	Mean CO_2e (Tonnes per Acre)	Sampling Error at 90% Confidence Interval	Sampling Error as a Percentage of the Mean Carbon Pool Estimate
Data Derived from Sampling						
				Example Data		
Standing Live Trees	Sampled within project boundaries	All project types	Required	95	6	6.32%
Standing Dead Trees	Sampled within project boundaries	All project types	Required	6	2	33.33%
Soil Carbon	Sampled within project boundaries	Avoided Conversion	Optional	65	8	12.31%
				Sum of Reported Pools	Calculation of Combined Sampling Error	Calculation of Combined Sampling Error as a Percentage
Summarizing Sampled Data				All Reported Pools from Sampling	Combined Sampling Error as a Percentage*Sum of All Reported Pools from Sampling Used to Determine the Confidence Deduction	$U_S = \frac{((U_1 \mathbf{x} R_1)^2+(U_2 \mathbf{x} R_2)^2+ \ldots +(U_n \mathbf{x} R_n)^2)^{\wedge}0.5}{\lvert R_1 + R_2 + \ldots + R_n \rvert}$ *Where*, U_S = percentage uncertainty of the sum U_i = percentage uncertainty associated with pool *i* R_i = removal (emission) estimate for pool *i*
Summary of Example Data from Sampled Pools				**166**	**10.20**	**6.14%**
Data Not Derived from Sampling						
Soil Carbon Emissions	Standardized Guidance	All Projects	Required	-5 (Example)	NA Not Subject to Sampling Error	NA Not Subject to Sampling Error
Pools Effected by Site Preparation	Sampled within Project Boundaries	Reforestation	Required	-5	NA Not Subject to Sampling Error	NA Not Subject to Sampling Error
Sum of Onsite CO_2e Tonnes				**156**	**NA**	**NA**

The per-acre unit must be expanded to the project area based on the number of acres in the project. The sum of onsite CO_2e tonnes for the project is input into the calculation worksheet for annual reporting.

2.11.1 Applying a Confidence Deduction to Sampled Estimates

Any forest carbon inventory derived from sampling will be subject to statistical uncertainty. Where statistical confidence is low, there is an increased 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, Project Operators 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. Confidence deductions are applied, where appropriate, to estimated onsite forest carbon stocks each reporting period.

2.11.2 Applying a Confidence Deduction to Non-Aggregated Projects

The target sampling error for the combined inventory estimates for non-aggregated projects is +/- 5 percent of the mean at the 90 percent confidence interval. Projects that cannot meet this target level are still eligible, but may have to take a "confidence deduction" that reduces their net reported carbon stocks.

The process for calculating the combined sampling error at the 90 percent confidence interval is shown above. The combined sampling error must be compared to the table below to determine the confidence deduction for the reporting period in which a site visit verification has occurred. The confidence deduction shall not be modified in the interim years between site visit verifications. The percent deduction from the table below is input into the calculation worksheet which calculates the net reported onsite stocks.

Table 2.21. Forest Carbon Inventory Confidence Deductions Based on Level of Confidence in the Estimate Derived from Field Sampling

Sampling Error (Percent of Inventory Estimate)	Confidence Deduction
0 to 5%	0%
5.1 to 19.9%	(Sampling Error – 5%) to the nearest 1/10 percentage
20% or greater	100%

2.11.3 Applying a Confidence Deduction for Aggregated Projects

The target sampling error for the combined inventory estimates for aggregated projects is on a sliding scale up to +/- 20 percent of the mean at the 90 percent confidence interval. The scale is based on the number of projects participating within the aggregate. Project Operators enrolled in an aggregate may submit project inventories with reduced sampling requirements based on the statistical principle that the targeted standard error (+/- 5 percent of the mean at the 90 percent confidence level) is achieved across the entire aggregate.

The target sampling error for the participant Project Operator ranges between 7 to 20 percent of the mean at the 90 percent confidence level based on the total number of projects in the aggregate as shown in Table 2.22 below.

Table 2.22. Target Sampling Error at the 90 Percent Confidence Level for Projects Participating in an Aggregate

Number of Participating Projects in the Aggregate	Target Sampling Error (TSE)
2	7%
3	8%
4	9%
5	10%
6	11%
7	12%
8	13%
9	14%
10	15%
11	16%
12	17%
13	18%
14	19%
15+	20%

For projects in an aggregate, confidence deductions are determined according to Table 2.23 (using the appropriate TSE from Table 2.22).

Table 2.23. Inventory Confidence Deductions for Participating Projects in an Aggregate

Actual Sampling Error at 90% Confidence Level	Confidence Deduction
If between 0% and TSE%	0%
If greater than TSE% and not greater than 20%	(Actual sampling error – TSE%) to the nearest 1/10 percentage
If greater than 20%	100%

The confidence deduction must be updated each time the project is subject to a site visit verification but must remain unchanged between verification site visits. If increased sampling over time results in a lower confidence deduction at the time of a site visit 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. Conversely, if a loss of qualified sampling plots results in a higher confidence deduction, this higher deduction must also be applied to inventory estimates in all previous years. Any resulting decrease in creditable GHG reductions and removals for prior years will be treated as an avoidable reversal, and must be compensated for by retiring CRTs in accordance with Section 7.3.2 of the Forest Project Protocol.

2.12 Requirements for Calculating Carbon in Harvested Wood Products

A portion of the carbon in harvested trees continues to be sequestered for long periods of time as wood products. Standardized guidance is provided to account for forest carbon that remains sequestered in harvested wood products. The protocol bases the accounting of harvested wood products on the average amount of carbon sequestered over a 100-year period. The 100-year period is consistent with the Forest Project Protocol's definition of permanence. The average amount of carbon remaining sequestered over the 100-year period is determined by calculating the amount of carbon delivered to the mills, the portion of the carbon that is converted to wood products using a coefficient that estimates the mill's efficiency, and determining the wood product classes manufactured by the mill, as different wood products have different decay rates.

An estimate of the average carbon remaining in use over the 100-year term is provided for each wood product class, which is the basis of baseline and annual reporting of harvested wood products. Furthermore, some wood products eventually end up in landfills where anaerobic conditions serve to reduce the rate of further decomposition. Since the amount of harvested wood products that end up in landfills and the actual decay rate of the wood products in landfills are highly uncertain, the accounting of harvested wood products in landfills is included only when it is conservative to do so. Conservative in this case means that if, in a given reporting year, the amount of harvested wood products in the baseline exceeds the amount of harvested wood products in the project activity, the carbon in landfills is reported. If there is more harvesting of wood products in the project case than in the baseline case, harvested wood products are not considered in either the baseline or the project case.

The Reserve has developed a spreadsheet tool to assist in the calculation of harvested wood products, which is available on the Reserve's Forest Project Protocol webpage. The Harvested Wood Products Calculation Worksheet contains step by step instructions for its use. Project reporting of harvested wood products occurs on an annual basis. The volume of logs delivered to the mill in the baseline case remains static throughout the project life. However, the mill efficiencies and the wood product classes identified in a reporting period are applied to the baseline harvested wood products the same way they apply to the project harvested wood products. The intent of this policy is to provide the best comparison of project activity to baseline activity possible.

The spreadsheet is designed with default values for converting volumetric units from logs delivered to mills to cubic feet and the values of mill efficiencies to be used on a geographic basis. The annual reporting of carbon in trees harvested for wood products is based on the relative proportion of volume in trees harvested for wood products and volume delivered to the mill(s) in the baseline case. Therefore, the reporting of volume delivered to mills is essential to calculating the volume in trees harvested for wood products.

Mill efficiency estimates from the actual mills the project logs are delivered to can be used if data exists to support the claim in a form that can be verified. Users must identify the mill(s) the project logs are delivered to and input the volume that is manufactured into lumber, plywood, oriented strand board, non-structural panels, miscellaneous products, and paper/pulp. Where the wood product class is unknown, the Project Operator must classify the product as miscellaneous products. In order to quantify unknown products categorized as miscellaneous conservatively, miscellaneous products are assigned a default storage factor of zero.

Project Operators must provide an affidavit from the mill that the reported wood product classes are reasonable according to production records at the mill, unless they use the default product classes provided in the Assessment Area Data file. Again, the wood product classes reported for a given reporting year apply both to the project and the baseline case which eliminates the calculation of project benefits or detriments based on comparisons of the decay rates of wood products alone.

3 Modeling Carbon Stocks

This protocol requires the use of certain empirical 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.

3.1 Models and their Eligibility for Use with Forest Projects

Empirical 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 (standing live and dead trees) provide the base input data for these models. Project Operators should be careful to ensure that all required data inputs for the models are included in the inventory methodology.

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. Plot data can be projected for the length of time the projection method is expected to accurately reflect actual forest growth. Inaccurate updating of plot data can lead to the inability of a project to be verified. Verifiers are directed to randomly select plots or stands for verification. If the Project Operator’s estimates deviate from the verifier’s measurements, the verification will fail. Hence, it is recommended to update plots at least every 12 years.

The following growth models have been approved:

- 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

The Reserve may also publish a baseline development tool in the future.

A Project Operator may update inventory plot data for estimating diameter and height growth by incorporating data obtained from sample plots, as in a stand table projection. An example of an appropriate method of applying a stand table projection is as follows:

1. The project area is stratified into even-age management and uneven-age management.

2. 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 inch diameter-at-breast-height (DBH) class, beginning at 0 to 8 inch DBH for each management type (even-age or uneven-age). The average annual increment shall be added for each year according to the plot's sample date.
3. Height increment is 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.

The Reserve may include additional models following approval of a state forestry authority (i.e., a state agency responsible for 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

3.2 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).

Standing live tree information 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. Standing dead trees must be assumed to be static over the baseline modeling. Exceptions to this rule are allowed if approved in writing by the Reserve prior to verification.

Projected baseline 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 forest project's start date. 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 of the Forest Project Protocol.

3.3 Modeling Requirements

A modeling plan must be prepared that addresses all required forecasting of baseline 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) for each silviculture method modeled.
    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 legal constraint, how the legal constraint affects the project area, and discusses 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 CO_2e of wood (CO_2e in logs delivered to mills) removed.

CLIMATE ACTION RESERVE

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Forest

Project Protocol

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Abbreviations and Acronyms

C	Carbon
CH_4	Methane
CO_2	Carbon dioxide
CRT	Climate Reserve Tonne
FIA	USFS Forest Inventory and Analysis[1]
FPP	Forest Project Protocol
FRAP	CAL FIRE Fire and Resource Assessment Program
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] http://fia.fs.fed.us/program-features/rpa/

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 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.

Only those Forest Projects that are eligible under and comply with the FPP may be registered with the Reserve. Section 9 of this protocol 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 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.

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 10 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 years) commercial opportunities. A Reforestation Project is only eligible if:

1. The project involves tree planting or removal of impediments to natural reforestation, on land that:
    a. Has had ten percent or less tree canopy cover for a minimum of ten years; or
    b. Has been subject to a Significant Disturbance that has removed at least 20 percent of the Project Area's live biomass in trees.
2. No rotational harvesting of reforested trees or any 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 Project Operator 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, or removal of impediments to natural reforestation, does not follow a commercial harvest of healthy live trees that has occurred in the Project Area within the past ten years, or since the occurrence of a Significant Disturbance, whichever period is shorter.
4. The project does *not* employ broadcast fertilization.
5. The project does not take place on land that was part of a previously registered Forest Project, unless the previous Forest Project was terminated due to an Unavoidable Reversal (see Section 7).

A Reforestation Project may involve subsequent tree harvesting and other silvicultural activities.

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 ten percent tree canopy cover.
2. The project employs natural forest management practices, as defined in Section 3.9.2 of this protocol.
3. The project does *not* employ broadcast fertilization.
4. The project does not take place on land that was part of a previously registered Forest Project, unless the previous Forest Project was terminated due to an Unavoidable Reversal (see Section 7).

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
- Maintaining stocks at a high level

Improved 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 at existing or increased stocking levels through a conservation easement or transfer to public ownership. An Avoided Conversion Project is only eligible if:

1. The Project Operator 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.
3. The project does not take place on land that was part of a previously registered Forest Project, unless the previous Forest Project was terminated due to an Unavoidable Reversal (see Section 7).

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

Avoided Conversion Projects are eligible only on lands that are privately owned prior to the project start date.

2.2 Forest Owners and Project Operators

A Forest Owner is an individual or a corporation or other legally constituted entity, city, county, state agency, or a combination thereof that has legal control of any amount of forest carbon[2] within the Project Area. Control of forest carbon means the Forest Owner has the legal authority to effect changes to forest carbon quantities, e.g., through timber rights or other forest management or land-use rights. Control of forest carbon occurs, for purposes of satisfying this protocol, through fee ownership and/or deeded encumbrances, such as conservation easements.

[2] See definition of Forest Carbon in glossary.

Multiple Forest Owners may exist with respect to a single Forest Project, since control of forest carbon may be associated with fee ownership or through one or more deeded encumbrances that exist within a Project Area, any one of which may convey partial control of the project's forest carbon. Any unencumbered forest carbon is assumed to be controlled by the fee owner. Individuals or entities holding mineral, gas, oil, or similar *de minimis*[3] interests in the forest carbon, are precluded from the definition of Forest Owner.

A Project Operator must be one of the Forest Owners. The Project Operator 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 Project Operator executes the Project Implementation Agreement (see Section 3.6) with the Reserve.

Where any Forest Owner chooses to exclude the forest carbon it controls from becoming part of the Forest Project, the project's baseline must demonstrate the exclusion as a legal constraint.

In all cases, the Project Operator must secure an agreement from all other Forest Owners that (1) assigns authority to the Project Operator to undertake a Forest Project, subject to any conditions imposed by any of the other Forest Owners to include or disallow any carbon they control; and (2) waives any right on the part of the Forest Owners to seek damages, penalties, costs, losses, expenses, or judgments from the Reserve arising from or in any way connected with the Forest Project, except as explicitly provided for in the PIA.

The Reserve maintains the right to determine which individuals or entities meet the definition of "Forest Owner."

The Project Operator may engage an independent third-party project developer to assist or consult with the Project Operator and to implement the Forest Project. All information submitted to the Reserve on behalf of the Project Operator shall reference the Project Operator, who is responsible for the accuracy and completeness of the information submitted, and for ensuring compliance with this Forest Project Protocol.

2.3 Forest Project Aggregation

Eligible Forest Projects[4] may be aggregated to improve cost-effectiveness while maintaining rigor in overall carbon inventory accounting. Individual Forest Projects can benefit through participation in an aggregate by meeting carbon inventory confidence standards across an aggregate, rather than within each project. This reduces the sampling intensity required within each project to meet statistical confidence requirements. Similarly, verification of aggregated projects is considered across the broader population, which reduces the verification costs to individual Project Operators participating in an aggregate. An aggregate consists of two or more individual Forest Projects enrolled with an Aggregator. For more information, please refer to the Guidelines for Aggregating Forest Projects.

[3] *de minimis* control includes access right or ways and residential power line right of ways.
[4] As described in the Guidelines for Aggregating Forest Projects available on the Reserve website.

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, crediting period, and management activities.

Section 3.1	Project Location	⟶	*U.S., U.S. Territories (reforestation and avoided conversion only), and tribal areas*
Section 3.2	Project Start Date	⟶	*No more than six months prior to project submission*
Section 3.3	Additionality	⟶	*Exceed legal requirements*
		⟶	*Meet performance standard*
Section 3.4	Project Crediting Period	⟶	*One hundred year crediting period*
Section 3.5	Permanence	⟶	*One hundred years following the issuance of CRTs*
Section 3.6	Project Implementation Agreement	⟶	*Project Operator executes PIA with the Reserve*
Section 3.7	Qualified Conservation Easement	⟶	*Optional*
Section 3.8	Regulatory Compliance	⟶	*Compliance with all applicable laws*
Section 3.9	Sustainable Harvesting and Natural Forest Management	⟶	*Ongoing compliance with the requirements for the project's assessment area(s)*

3.1 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 projects can be transferred from private to public lands, whereby the public entity acquires all terms and conditions described in this protocol.

All Improved Forest Management Projects that are on public lands as of the project's start date 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 a federal legislative or regulatory/rulemaking process. Forest Projects in tribal areas must demonstrate that the land within the Project Area is owned by a tribe or private entities.

Companion documents to Version 4.0 of the Forest Project Protocol contain data tables, equations, and benchmark data applicable to projects located in the United States. The Reserve may add approved equations and models as they are developed in future versions of the Forest Project Protocol.

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, particularly for Improved Forest Management Projects. Reforestation and Avoided Conversion are eligible in U.S. Territories, as they do not depend on the U.S.-specific data sets mentioned above.

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, the removal of impediments to natural regeneration, 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, or transferring the Project Area to public ownership (see further guidance below).
- For an Avoided Conversion Project, the action is committing the Project Area to continued forest management and protection through recording a conservation easement with a provision to maintain the Project Area in forest cover or transferring the Project Area to public ownership where the Project Area will be maintained in forest cover.

Projects must be submitted to the Reserve within 6 months of their project start date.[5]

An Improved Forest Management project's start date must be linked to a discrete, verifiable action that delineates a change in practice relative to the project's baseline. Project Operators may choose to identify one of the following actions:

- Recordation of a conservation easement on the Project Area. The project start date is the date the easement was recorded.
- Transferring of property ownership (to a public or private entity). The project start date is the date of property transfer.
- Submitting the project to the Reserve.[6] The project start date is the date of submittal, provided that the project completes verification within 30 months of being submitted. If the project does not meet this deadline, it must be resubmitted under the latest version of the protocol; it will not retain the initial submittal date and will be subject to any new project start date requirements.

[5] 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/.
[6] Submitting a project to the Reserve is considered an initiation of a commitment to employ practices that will maintain or grow net carbon stocks for the duration of the FPP's commitment period, per the requirements of the FPP and signing the Project Implementation Agreement (PIA).

Project Operators must affirm the action denoting the project start date by providing documentation. Adequate documentation could include deeds of trust, title reports, conservation easement documentation, dated forest management plans, and/or contracts or agreements.

3.3 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/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 management plans (such as Timber Harvest Plans) that are required for government agency approval of harvest activities.

   Deeded encumbrances, such as timber deeds or conservation easements, may effectively control forest carbon, such that there may be multiple Forest Owners within the Project Area. Deeded encumbrances are considered legally binding mandates for the purposes of the legal requirement test, unless they are recorded within a year of the Forest Project's start date with clear agreement from all Forest Owners.

   Deeded encumbrances may contain terms that do not directly refer to forest carbon, but that nevertheless restrict the effect the ability of any one Forest Owner to change forest carbon stocks. These terms must be interpreted with respect to their effect on forest carbon for the purposes of the legal requirement test and baseline determinations. Where the terms of deeded encumbrances are not explicit with regards to forest carbon, the following assumptions shall be made:
   a. Restrictions or references related to canopy cover, basal area, density, volume, carbon or biomass apply to standing live and dead trees of all species.
   b. Carbon in other pools (soil, litter, duff, shrubs, etc.) is assumed to be associated with the other defined terms, such as trees.
   c. Terms related to forest (tree) growth apply to growth in all tree species.

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 3.3.2).

   Project quantification (Section 6) further ensures that forest projects are additional via checks on financial feasibility.

3.3.1 Legal Requirement Test

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

3.3.1.1 Reforestation Projects

At the Forest Project's initial verification, the Project Operator must sign the Reserve's Attestation of Voluntary Implementation form indicating that the project's reforestation activities are not legally required (as defined above) and were not legally required at the time of the project's start date.

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

3.3.1.2 Improved Forest Management Projects

At the Forest Project's initial verification, the Project Operator must sign the Reserve's Attestation of Voluntary Implementation form indicating that the Forest Project is not legally required (as defined above) and was not legally required at the time of the project's start date. For the purposes of the attestation, the "Project" is defined as maintaining onsite carbon stocks at or above their current levels (at the time the attestation is signed) for at least 100 years.

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

3.3.1.3 Avoided Conversion Projects

At the Forest Project's initial verification, the Project Operator must sign the Reserve's Attestation of Voluntary Implementation form indicating that the Forest Project's planned forest conservation activities are not legally required (as defined above) and were not legally required at the time of the project's start date.

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

3.3.2 Performance Test

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

3.3.2.1 Reforestation Projects

A Reforestation Project that occurs on land that has had ten percent or less tree canopy cover for at least ten 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 B, Table B.1, indicating that it is "eligible" (as determined by the guidance in Appendix B); or
2. The Forest Project occurs on a type of land that has not historically been involved in or allowed timber harvesting. (Examples of such land include municipal or state parks.)

3.3.2.2 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.

3.3.2.3 Avoided Conversion Projects

An Avoided Conversion Project satisfies the performance test if the Project Operator 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.
2. The appraisal must conform with the following minimum standards[7]:
    a. Appraisal reports shall be prepared and signed by a Licensed or Certified Real Estate Appraiser in good standing.
    b. Appraisal reports shall include descriptive photographs and maps of sufficient quality and detail to depict the subject property and any market data relied upon, including the relationship between the location of the subject property and the market data.
    c. Appraisal reports shall include a complete description of the subject property land, site characteristics and improvements. Valuations based on a property's development potential shall include:
        i. Verifiable data on the development potential of the land (e.g., Certificates of Compliance, Tentative Map, Final Map).
        ii. A description of what would be required for a development project to proceed (e.g., legal entitlements, infrastructure).
        iii. Presentation of evidence that sufficient demand exists, or is likely to exist in the future, to provide market support for the development.
        iv. Where conversion to commercial, residential, or agricultural land uses is identified as the highest value alternative land use, the appraisal must demonstrate that the slope of Project Area land is compatible with the alternative land use by identifying two areas with similar average slope conditions to the Project Area that have been converted within the past ten years in the project's Assessment Area. Alternatively, the Project Area must have an average slope less than 40 percent.
        v. Where conversion to agricultural land use is anticipated, the appraisal must provide:
            1) Evidence of soil suitability for the type of expected agricultural land use.
            2) Evidence of water availability for the type of expected agricultural land use.
            3) 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.
        vi. 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
    d. Appraisal reports shall include a statement by the appraiser indicating to what extent land title conditions were investigated and considered in the analysis and value conclusion.

[7] Adapted from Sections 5096.501 and 5096.517, Public Resources Code, State of California.

e. Appraisal reports shall include a discussion of implied dedication, prescriptive rights or other unrecorded rights that may affect value, indicating the extent of investigation, knowledge, or observation of conditions that might indicate evidence of public use.
f. Appraisal reports shall include a separate valuation for ongoing forest management prepared and signed by a certified or registered professional qualified in the field of specialty interest. This valuation shall be reviewed and approved by a second qualified, certified or registered professional, considered by the appraiser, and appended to the appraisal report. The valuation must identify and incorporate all legal constraints that could affect the valuation of both the ongoing forest management.
g. The appraisal must provide a map that displays specific portions of the Project Area that are 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.). The smaller of the two areas identified in the appraisals must be used.

3. *The alternative land use for the Project Area has a higher market value than maintaining the Project Area for sustainable forest management.* The appraisal for the property must provide a value for the current forest land use condition of the Project Area and a fair market value of the anticipated alternative land use for the Project Area. The anticipated alternative land use for the Project Area must be at least 40 percent greater than the value of the current forested land use.

The appraisals must be conducted in accordance with the Uniform Standards of Professional Appraisal Practice[8] and the appraiser must meet the qualification standards outlined in the Internal Revenue Code, Section 170 (f)(11)(E)(ii).[9]

3.4 Project 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.

3.5 Permanence

Project Operators 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 Forest Projects must undergo an initial site visit verification to register with the Reserve. After the initial verification, all Forest Projects must undergo a site visit verification at least once every six years. The only exception

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

[9] 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."

to this rule is for Reforestation Projects, which may defer a second site visit verification beyond six years, at the Project Operator's discretion. The third and subsequent site visit verifications for Reforestation Projects must continue on a six-year cycle.

There are three possible exceptions to this minimum time commitment:

1. A Forest Project automatically terminates if a Significant Disturbance occurs,[10] 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 Project Operator 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 Project Operator 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 breach of certain terms described within the Project Implementation Agreement. Such a termination will require the Project Operator to retire a quantity of CRTs, as specified under 'Retiring CRTs Following Project Termination' below.

Retiring CRTs Following Project Termination

1. For a Reforestation or Avoided Conversion Project, the Project Operator 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.
2. For an Improved Forest Management Project, the Project Operator 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.
3. For any project seeking to terminate project activities on only a portion of the project area, the change must be treated as a potential Avoidable Reversal. If it is determined that the revision to the project area would lead to an Avoidable Reversal, then credits must be retired as described in Section 7.3.2. Improved Forest Management projects must also apply the early termination compensation rate in Table 3.1 below. If the revision to the project area would lower standing live carbon stocks below baseline levels, then this will be considered a complete project termination.
4. 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 an Avoidable Reversal.

[10] The natural disturbance shall not be the result of intentional or grossly negligent acts of any of the Forest Owners.

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

3.6 Project Implementation Agreement

For a Forest Project to be eligible for registration with the Reserve, the Project Operator is required to enter into a Project Implementation Agreement (PIA) with the Reserve. The PIA is an agreement between the Reserve and a Project Operator setting forth: (i) the Project Operator's obligation (and the obligation of its successors and assigns) to comply with the Forest Project Protocol, and (ii) the rights and remedies of the Reserve in the event of any failure of the Project Operator to comply with its obligations. The PIA must be signed by the Project Operator before a project can be registered with the Reserve. It must be signed by all entities that are fee simple owners of the Project Area property. The PIA is recorded and submitted after the Reserve has reviewed the verification documents and is about to register the project.

3.7 Use of Qualified Conservation Easements or Qualified Deed Restrictions

A Qualified Conservation Easement is a conservation easement that explicitly (1) refers to, and incorporates by reference, the terms and conditions of the PIA agreed to by the Project Operator, thereby binding both the grantor and grantee – as well as their subsequent assignees – to the terms of the PIA for the full duration of the Forest Project's minimum time commitment, as defined in Section 3.5 of this protocol; (2) makes all future encumbrances and deeds subject to the PIA; and (3) makes the Reserve a third party beneficiary of the conservation easement.

A Qualified Deed Restriction is a deed restriction that ensures that the Project Implementation Agreement runs with the land and explicitly (1) refers to, and incorporates by reference, the terms and conditions of the PIA agreed to by the Project Operator, thereby Project Operator—as well as their subsequent assignees to the terms of the PIA for the full duration of the Forest Project's minimum time commitment, as defined in Section 3.5 of this protocol; (2) makes all future encumbrances and deeds subject to the PIA; and (3) makes the Reserve a third party beneficiary of the deed restriction. A deed restriction is not "qualified" if it merely consists of a recording of the Project Implementation Agreement or a notice of the Project Implementation Agreement, as such a recording is already required by the Project Implementation Agreement. The Reserve maintains the discretion to determine whether a deed restriction meets the terms to be considered a Qualified Deed Restriction.

Qualified Conservation Easements or Qualified Deed Restrictions may be voluntarily employed with any project type. 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 A.

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 3.3.1) and in determining the project's baseline (Section 6).

3.8 Regulatory Compliance

Each time the Forest Project is verified, the Project Operator must attest that the project is in material compliance with all applicable laws relevant to the project activity. For this protocol, instances of non-compliance are likely to be considered "material" if they directly pertain to the management of project carbon stocks. Project Operators are required to disclose in writing to the verifier any and all instances of material non-compliance of the project with any law. If a verifier finds that a project is in a state of material non-compliance, then CRTs will not be issued for GHG reductions that occurred during the period of non-compliance. Non-compliance solely due to administrative or reporting issues, or due to "acts of nature," will not affect CRT crediting.

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. To be in conformance with this protocol, Forest Projects must:

1. Employ sustainable long-term harvesting practices, both within their Project Area and on other forest landholdings controlled by the Project Operator and its Affiliate(s) within the project's Assessment Area(s), as described in Section 3.9.1. Forest landholdings are considered "controlled" by the Project Operator if the Project Operator owns the land in fee, or has been deeded timber rights on it.
2. Employ Natural Forest Management practices within the Project Area, including meeting species composition, forest structure, and age and habitat distribution requirements, as described in Section 3.9.2.
3. Maintain or increase standing live carbon stocks over the project life, as described in Section 3.9.3.

3.9.1 Sustainable Harvesting Practices

At the time commercial harvesting is initiated on any of the forest landholdings controlled by the Project Operator and its Affiliate(s) within the project's Assessment Area(s), the Project Operator and its Affiliate(s) must employ and demonstrate sustainable long-term harvesting practices on all of its forest landholdings within the project's Supersection(s), including the Project Area, using one of the following options:

1. Certification under the Forest Stewardship Council, Sustainable Forestry Initiative, or Tree Farm System certification programs. Regardless of the program, the terms of certification must require adherence to and verification of harvest levels which can be permanently sustained over time.

2. Adherence to a renewable long-term (50 years minimum) 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 (for federal lands only).
3. The use of silvicultural practices (if harvesting occurs) that maintain canopy cover averaging at least 40 percent, as measured on any 20 acres of the Project Operator's and its Affiliate(s') landholdings within the project's Supersections(s), including the Project Area.[11] Exceptions may be granted by the Reserve where it can be demonstrated that the harvest openings are intended to restore plantations to forest conditions with greater species diversity. The Project Operator is not responsible for harvest openings that preceded their ownership if the previous ownership had no direct business affiliation with the current ownership.
4. Adherence to a deeded conservation easement(s) with terms that ensure growth equals or exceeds harvest over time.

This requirement shall be met always during the project life and is assessed at each site visit verification. Failure to meet this requirement will result in all Reserve account activity being suspended until it is met.

Project Operators and their Affiliate(s) who acquire new forest landholdings within the project's Assessment Area(s) have up to five years to incorporate such acquisitions under their certification or management plan, or otherwise must abide immediately by the terms of the Sustainable Harvesting Practices, 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 within the Project Area and at multiple landscape scales ("Natural Forest Management").

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 show verified progress (verified at scheduled site visit verifications) towards native tree species composition and distribution requirements described below, consistent with the forest type and forest soils native to the Assessment Area.
2. Forest Projects must manage the distribution of habitat/age classes and structural elements, as described below, to support functional habitat for locally native plant and wildlife species naturally occurring in the Project Area.

Forest Projects must incorporate the criteria for Natural Forest Management throughout the project life. The information provided in Table 3.3 shall be used to determine if the Forest Project meets the criteria for engaging in Natural Forest Management. This evaluation must be completed and verified at a Forest Project's initial verification and at all subsequent verifications. Forest Project carbon stock inventories (requirements for which are found in the Quantification Guidance on the FPP webpage) should be used as the basis of these assessments where applicable. Forest Projects that do not initially meet Natural Forest Management criteria but can

[11] Areas impacted by Significant Disturbance may be excluded from this test.

demonstrate progress towards meeting these criteria at the times identified in Table 3.3 are compliant with the protocol.

1. Species Composition

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.

For the purposes of the FPP, the definition of native forests for each Assessment Area is based on reference metrics provided in an Assessment Area Data File, a companion document to the FPP available on the Reserve's website. The planting of native species outside of their current distribution is allowed up to 5% of the overall native species requirement as an adaptation strategy due to climate change. Plantings that will result in more than 5% of native species from beyond their current distribution 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. In all cases, the Project Operator must obtain a written statement from the government agency in charge of forestry regulation in the state where the project is located stipulating that the planting of native trees outside their current range is appropriate as an adaptation to climate change. The specifications for meeting the requirements for species composition are included in Table 3.3.

2. Forest Structure

A variety of silvicultural practices may be employed in the Project Area during the course of a Forest Project, though the protocol does not endorse any particular practice. Any practices employed, however, must meet a minimum set of standards to ensure environmental integrity associated with a balanced distribution of age and habitat classes across the landscape, as well as certain structural elements within the forest.

Harvesting may be conducted within forest projects using a variety of silviculture methods. However, to ensure harvest practices maintain habitat refugia, even-aged rotations are limited to the following guidelines in Table 3.2.

Table 3.2. Even-Aged Management Retention Guidelines

Harvest Retention (Square Feet Basal Area/Acre of All Species)	**Maximum Size of Harvest Block** (Acres)
0	40
>= 15 < 20	60
>=20 < 25	80
>=25 < 30	120
>= 30 < 40	400
>= 40 < 50	600
>=50	Unlimited

Where any harvest occurs in harvest blocks where the harvest retention is less than 50 square feet of basal area per acre, additional harvesting may only occur within 300 feet of the harvest area (with less than 50 square feet basal area per acre) if the harvest retention of the additional harvest exceeds 50 square feet of basal area per acre. This requirement shall remain in place until the regeneration within the original harvested area (i.e., with retention less than 50 square feet basal area per acre) achieves a height of five feet or is five years old.

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 20 years after reforestation of such areas.

The protocol does not override a landowner's obligation to abide by applicable laws and regulations, including any governing forest practice rules that may be more stringent. Regardless of the silvicultural practice employed, landowners must fulfill their commitment under the protocol to permanently maintain or increase onsite standing live carbon stocks (i.e., the carbon in live trees within the Project Area) as specified in Section 3.9.3.

Structural elements such as standing dead trees and lying dead wood are features typically found in natural forests. They provide a variety of benefits, including wildlife habitat. Management of Forest Projects must ensure that standing dead trees and lying dead wood are present on the Project Area at certain minimum levels in accordance with the requirements outlined in Table 3.3.

Table 3.3. Evaluation Criteria to Test if a Forest Project Meets the Requirement for the Establishment and Maintenance of Native Species and Natural Forest Management

Criteria	Assessment	Application Rules
Native Species		
Project consists of at least 95% native species, or demonstrates continuous progress over 50 years toward 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 for the first 12 years of a reforestation project and basal area per acre for Improved Forest Management, Avoided Conversion Projects, and Reforestation Projects over 12 years.	Assessed at initial verification from inventory data. Assessment during site visit verifications must demonstrate continuous compliance with goal (if already met) or continuous progress toward the goal (if not yet met).	Applies to all project types throughout the project life. If criterion is not met within 50 years, all the Forest Project's Reserve account activity will be suspended until the criterion is met.

Composition of Native Species		
Improved Forest Management, Avoided Conversion Projects, and Reforestation Projects older than 12 years. No single species' prevalence, measured as the percent of the basal area of all live trees in the Project Area, exceeds the percentage value shown under the heading 'Composition of Native Species' in the Assessment Area Data File maintained on the Reserve's website. **Early Reforestation (Less than 12 years)** To the extent seed is available, and/or physical site characteristics permit, Reforestation Projects must achieve a mixture of native species 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 the Assessment Area Data File maintained on the Reserve's website. **All Projects** Where the Project Area naturally consists of a single species dominance, the Project Operator may obtain a letter from the State Forester or his/her representative stating that the Project Area's species diversity is reflective of background natural species diversity (despite any inconsistencies with the Assessment Area Data File). Projects 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	Species composition is assessed at initial verification from inventory data. Species composition is also assessed during the project at each site visit verification.	Applies to all project types throughout the project life. All the project's Reserve account activity will be suspended until the criterion is met (excluding the aforementioned exceptions).
Distribution of Age Classes		
On a watershed scale up to 10,000 acres (or the Project Area, whichever is smaller), 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 excluded from this test.) Applies to all project types at first commercial harvest. Project must show continuous progress toward criterion. This criterion must be met within 25 years	Age classes are assessed during project life at each site visit verification.	All Reserve account activity will be suspended until the criterion is met.
Structural Elements (Standing and Lying Dead Wood)		
Project Operators must ensure that dead wood is recruited and maintained in sufficient quantities, as described below. **Option I**. Monitoring dead wood throughout Project Area. Project Operators may maintain inventories of lying dead wood as part of their normal inventory processes. Where inventory measurements are used to demonstrate	Assessed during project at each site visit verification.	Applies to all project types throughout the project life. All Reserve account activity will be suspended until the areas verified since the previous site-verification meet the requirement.

compliance with this requirement, monumented plots or line transects must be used so the plot data can be verified. Dead wood measurements must achieve a minimum statistical confidence of +/- 30% at 1 Standard Error. The combination of standing dead and lying dead wood shall be retained at average per acre values at quantity levels identified in the Assessment Area data file. If dead material does not exist at the quantities identified in the Assessment Area data file, dead trees shall be recruited as described below for Option II. **Option II**: Monitoring dead wood on harvested areas. The assessment of sufficient lying and standing dead material shall be made in areas harvested since the last site verification. **For portions of the Project Area that have been harvested under normal circumstances (not salvage harvested):** The combination of standing dead and lying dead wood shall be retained at average per acre values at quantity levels identified in the Assessment Area data file within each harvested unit. If dead material does not exist at the required levels within the harvest units, live trees shall be retained and tagged with aluminum tags at three times the amount identified in the Assessment Area data file minus whatever quantity does exist within each harvest unit. **For portions of the Project Area that have been salvage harvested:** The combination of standing dead and lying dead wood shall be retained at a combined four tonnes per acre on average within each harvest unit. Verification that the requirement has been met shall be conducted using the methodology for verification of dead material transects found on the Quantification Guidance on the FPP webpage. **Option III:** No harvesting Projects without any harvesting activities within the project area do not need to monitor specifically for structural elements.		

3.9.3 Promotion of the Onsite Standing Live Carbon Stocks

To promote and maintain the environmental benefits of Forest Projects, the Reserve requires that the standing live carbon stocks within the Project Area be maintained and/or increased during the project life. Therefore, 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 ten-year consecutive period – indicate a decrease in the standing live carbon stocks.

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 carbon stocks; where reductions are due to non-harvest disturbances; or where reductions are required by law. 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 Project standing live carbon stocks that have decreased over a ten-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 Project Operator 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 Project Operator 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).

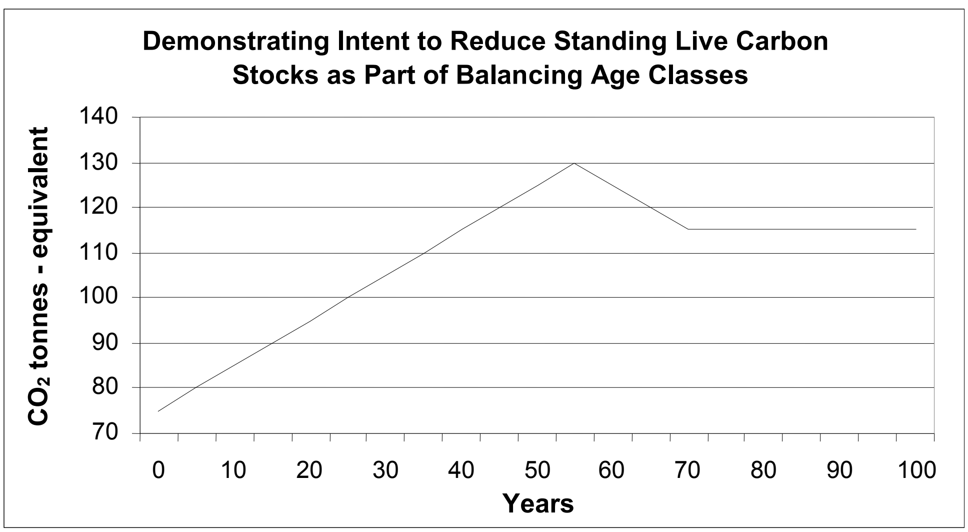


Figure 3.1. Example of Reducing Standing Live Carbon Stocks as Part of Balancing Age Classes

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 overall

trend will be for standing live carbon stocks to increase or stay the same over the life of the project (Figure 3.2).

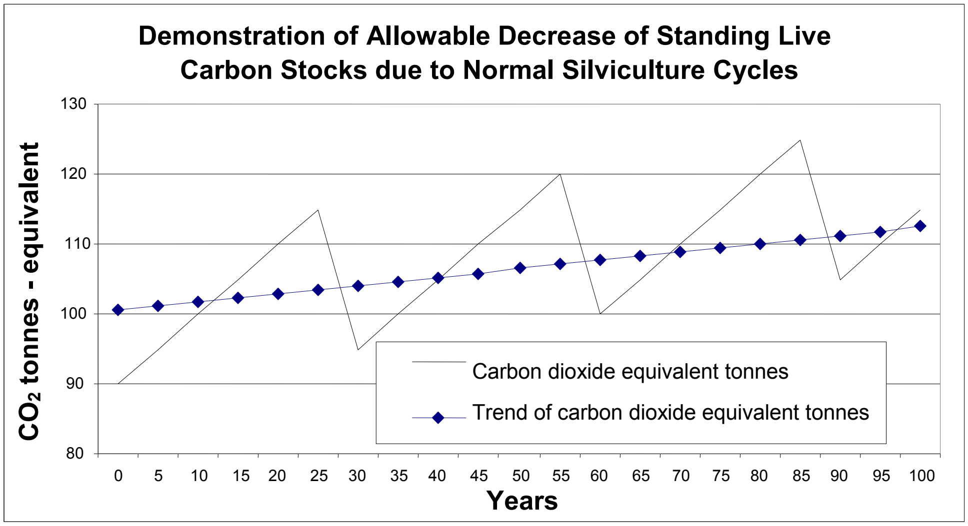


Figure 3.2. Example of Allowable Decrease of Standing Live Carbon Stocks due to Normal Silviculture Cycles

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, or maps that displays public and major private roads, major watercourses (fourth order or greater), topography, towns, and Public Land Survey Townships, Ranges, and Sections or latitude and longitude. The maps must be of adequate resolution to clearly identify the required features.

Once a project's Supersection(s) has been identified, Assessment Area(s) must be determined. A project may do this by comparing dominant species present in the project inventory to the list of native species provided in the Assessment Area Data File. Projects may also utilize Landfire Existing Vegetation Types (EVT) to determine the most appropriate Assessment Areas for the project. EVT descriptions must be used to identify the species descriptions that most closely match the native species provided in the Assessment Area Data File. The Reserve also reserves the right to provide a spatially explicit map of Assessment Areas to be used for identification purposes. The Project Area may also extend across multiple Assessment Areas within a Supersection (see Guidance for Determining Common Practice on the Assessment Area Data webpage), and across no more than two adjacent Supersections.

A Geographical Information System (GIS) file depicting the Project Area must be submitted to the Reserve with the project. The file must be submitted in the KML file format. The Project Area can be contiguous or separated into tracts or distinct polygons. Additionally, the current assessor's parcel identification numbers associated with the project area must be submitted to the Reserve.

For Improved Forest Management Projects, the geographic boundaries may be defined such that non-forested areas, or areas not under forest management, are excluded from the Project Area.

For Reforestation Projects, the Project Area must be on land that has had less than ten 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 percent of the carbon stocks being emitted. Reforestation Projects may submit a provisional project boundary that must be amended to the actual areas reforested within the provisional project boundary by the second site visit verification.

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 having a 'higher and better use' in residential development.
Agricultural Conversion	The boundary of the parcel or parcels that have been appraised as having a 'higher and better use' in agricultural production.
Golf Course	The boundary of the parcel or parcels that have been appraised as having a 'higher and better use' as a golf course. This is to include forested areas within 200 feet of fairways, greens, and buildings.
Commercial Buildings	The boundary of the parcel or parcels that have been appraised as having a 'higher and better use' in commercial buildings. This is to include forested areas with 200 feet of suitable building sites.

Once the Project Area is defined, the Supersection(s) and Assessment Area(s) comprising the project must be identified. Whereas the physical location of the project determines the relevant Supersection(s), the species composition of the Project Area determines which Assessment Area(s) comprises the project. A project's Supersection(s) is identified by comparing the spatial data delineating the Project Area with spatial data representing the Supersections established by the Reserve (available on the Assessment Area Data webpage). Assessment Area(s) are determined by comparing dominant species present in the project inventory to the list of native species provided in the Assessment Area Data File. Projects may also utilize Landfire Existing Vegetation Types (EVT) to determine the most appropriate Assessment Areas for the project. EVT descriptions must be used to identify the species descriptions that most closely match the native species provided in the Assessment Area Data File. The Reserve also reserves the right to provide a spatially explicit map of Assessment Areas to be used for identification purposes.

The Project Area may extend across multiple Assessment Areas within a Supersection (see Guidance for Determining Common Practice on the Assessment Area Data webpage), but may be distributed across no more than two adjacent Supersections.

4.1 Project Configuration and Limitations

To ensure Project Areas are representative of the Forest Owner's general forest management, Improved Forest Management projects must include all forested areas within an area no smaller than an area defined by 3rd order watersheds or the entire area owned by the Forest Owner, whichever is smaller. Exceptions may be provided if approved by the Reserve. Non-forested areas (brush, rocks, range, etc.) may be excluded from all project types. Forest Projects can consist of disparate polygons (areas).

4.2 Project Area Acreage

Project acreage shall be based on area calculations derived from GIS analysis, such as ArcGIS or Google Earth. GIS data are generally considered to be improvements over strict adherence to county parcel acreages as they are based on correcting property boundaries to geographic characteristics and/or property corners as described in property deeds or official survey notes. A KML (Google Earth) file depicting the Project Area shall be included with the PDD.

The project must list the county assessor's parcels (APs), the portion of each AP included in the project (as a percentage), the sum of acres derived from the county tax records for all included APs, and the sum of acres derived from the GIS analysis. The sum of acres should be compared between the AP and GIS sources, with the lesser of the two used for the project area.

If there is a significant discrepancy between AP and GIS acres, the Project Operator may work with the county assessor to resolve any disputed AP acres.

4.3 Modifying the Project Area

It is possible for project activities to be terminated on a portion of the Project Area. These adjustments must be treated as Avoidable Reversals, as described in Section 3.5. If a project proceeds with terminating the project on a portion of the Project Area, a new KML file must be provided to reflect the new Project Area. An addendum to the Project Design Document (PDD) must also be submitted to reflect this change, and the new legal description of the project will be recorded with the next PIA or PIA Amendment after the change has been verified. The inventory for the modified Project Area will be assessed during the next regularly scheduled site visit verification, unless it is determined that an Avoidable Reversal has taken place, in which case, the guidance in Section 7.3.2 must be followed.

5 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 predominantly 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).[12] Secondary Effects may include increases in mobile combustion CO_2 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.

The following tables provide a comprehensive list of the GHG sources, sinks, and reservoirs (SSRs) that may be affected by a Forest Project, and indicate which SSRs must be included in the GHG Assessment Boundary for each type of Forest Project. If a SSR is designated as a "reservoir/pool," this means that GHG reductions and removals are accounted for by quantifying changes in carbon stock levels. For SSRs designated as sources or sinks, GHG reductions and removals are accounted for by quantifying changes in GHG emission or removal rates, as described in the tables.

5.1 Reforestation Projects

Table 5.1. GHG Assessment Boundary – Reforestation Projects
All optional pools included in Forest Project must independently meet minimum confidence requirements for inclusion.

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
Primary Effect Sources, Sinks, and Reservoirs						
RF-1	Standing live carbon (carbon in all portions of living trees)	Reservoir / Pool	CO_2	*Included*	**Baseline:** Modeled based on initial field inventory measurements **Project:** Measured by field measurements and updating forest carbon inventory	Increases in standing live carbon stocks are likely to be the largest Primary Effect of Reforestation Projects. For baseline estimation purposes, 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 Project Operator first seeks verification of GHG reductions and removals (subsequent to the project's initial site visit verification and registration).

[12] 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.

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
RF-2	Shrubs and herbaceous understory carbon	Reservoir / Pool	CO_2	*Included for site preparation activities*	**Baseline:** Measured and assumed to be static with start date inventory estimates **Project:** Estimated decrease at project initiation with site preparation and assumed static thereafter	Shrubs and herbaceous understory may constitute a significant portion of carbon affected by Reforestation Projects as part of site preparation.
RF-3	Standing dead carbon (carbon in all portions of dead, standing trees)	Reservoir / Pool	CO_2	*Included for project activities*	**Baseline:** N/A **Project:** Measured by updating forest carbon inventory. Does not include pre-existing dead and dying trees at project commencement.	Reforestation Projects are often implemented following disturbance events. Dead trees may continue to fall, become lying dead wood, and contribute to a reversal, even though the primary effect of planting trees continues to increase over time. The protocol requires recruitment and retention of dead material, including standing dead wood as a structural element, so further quantification is not required for standing dead carbon present at project commencement. Minimum volume thresholds are stated to meet Natural Forest Management criteria. (See Section 3.9.2). However, projects must measure planted trees that become standing dead trees, as this is part of the project's primary effect. Projects should define the project year in which standing dead carbon will begin to be measured in the Project Design Document.
RF-4	Lying dead wood carbon	Reservoir / Pool	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Lying dead wood may constitute a significant amount of carbon affected by Reforestation Projects as part of site preparation. However, it is assumed that a comparable quantity of lying dead wood will decompose over the course of the 100-year modeled baseline. Since no significant change is expected between the baseline and project scenarios, lying dead wood will be accounted for through the Natural Forest Management criteria. For Natural Forest Management criteria, the protocol requires recruitment and retention of dead material, including lying dead wood as a structural element. Minimum volume thresholds are stated to meet Natural Forest Management criteria. (See Section 3.9.2).
RF-5	Litter and duff carbon (carbon	Reservoir / Pool	CO_2	*Excluded*	**Baseline:** N/A	Carbon from litter and duff may be affected by Reforestation Projects

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
	in dead plant material)				**Project:** N/A	as part of site preparation, but the emission source is assumed to be *de minimis*.
RF-6	Soil carbon	Reservoir / Pool	CO_2	*Included*	**Baseline:** Assumed to be static with start date inventory estimates **Project:** Emissions from project activities estimated with standardized guidelines in the Soil Quantification Guidance on the FPP webpage	Soil carbon may constitute a significant portion of carbon affected by reforestation projects. All projects must use standardized guidance to account for potential soil carbon emissions associated with management activities.
RF-7	Carbon in in-use forest products	Source / Sink	CO_2	*Included*	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes	Included because many Reforestation Projects will significantly increase carbon storage in in-use forest products relative to baseline levels. Treated as a "source/sink" because forest product carbon is quantified according to the change in harvesting volumes, relative to baseline levels, in each year. Of this change (increase or decrease), only the average amount of carbon expected to remain stored for 100 years is included in the final quantification of annual net GHG removals/emissions. This approach accounts for CO_2 emissions from decomposition or disposal of wood products (see SSR RF-17).
RF-8	Forest product carbon in landfills	Reservoir / Pool	CO_2	*Excluded when project harvesting exceeds baseline* *Included when project harvesting is below baseline*	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes	Because of significant uncertainties associated with forecasting the quantity of forest product carbon that will remain stored in landfills, landfill carbon is excluded from quantification in years when project harvesting volumes exceed baseline volumes. Landfill carbon is included, however, in years when project harvesting volumes are below baseline levels. This case-dependent exclusion or inclusion is necessary to ensure that total GHG reductions and removals caused by the Forest Project are not overestimated.
Secondary Effect Sources, Sinks, and Reservoirs						
RF-9	Biological emissions from site preparation activities	Source	CO_2	*Included*	**Baseline:** N/A **Project:** Quantified based on measured carbon stock changes in included reservoirs as part of site preparation (see above)	Biological emissions from site preparation are not quantified separately, but rather are captured by measuring changes in included carbon reservoirs (shrubs and herbaceous understory; soil carbon where applicable). Reforestation Projects are not eligible if harvesting of live trees

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
						(standing live carbon) has occurred within the Project Area within the last 10 years.
RF-10	Mobile combustion emissions from site preparation activities	Source	CO_2	*Included*	**Baseline:** N/A **Project:** Estimated using default emission factors	Mobile combustion CO_2 emissions from Reforestation Project site preparation activities can be significant relative to total GHG reductions/removals. In general, this protocol assumes that combustion emissions in the U.S. will be controlled under a regulatory cap-and-trade program in the near future, and can therefore be ignored in the context of Forest Project GHG accounting. Since these emissions are not currently capped, however, and because site preparation is a one-time event rather than an ongoing source of emissions, mobile combustion emissions are included in the GHG Assessment Boundary for this version of the Forest Project Protocol.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in CH_4 emissions from mobile combustion associated with site preparation activities are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in N_2O emissions from mobile combustion associated with site preparation activities are not considered significant.
RF-11	Mobile combustion emissions from ongoing project operation and maintenance	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Mobile combustion CO_2 emissions from ongoing project operation and maintenance are unlikely to be significantly different from baseline levels, and are therefore not included in the GHG Assessment Boundary. In addition, this protocol assumes that such emissions will be controlled under a regulatory cap-and-trade program in the near future, meaning that changes in activity due to the Forest Project will have no effect on total net emissions.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	CH_4 emissions from mobile combustion associated with ongoing project operation and maintenance activities are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	N_2O emissions from mobile combustion associated with ongoing project operation and maintenance activities are not considered significant.
RF-12	Stationary combustion emissions from	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Stationary combustion CO_2 emissions from ongoing project operation and maintenance could

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
	ongoing project operation and maintenance					include GHG emissions associated with electricity consumption or heating/cooling at Project Operator facilities, or at facilities owned or controlled by contractors. These emissions are unlikely to be significantly different from baseline levels, and are therefore not included in the GHG Assessment Boundary. In addition, this protocol assumes that such emissions will be controlled under a regulatory cap-and-trade program in the near future, meaning that changes in activity due to the Forest Project will have no effect on total net emissions.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	CH_4 emissions from stationary combustion associated with ongoing project operation and maintenance activities are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	N_2O emissions from stationary combustion associated with ongoing project operation and maintenance activities are not considered significant.
RF-13	Biological emissions from clearing of forestland outside the Project Area	Source	CO_2	*Included*	**Baseline:** N/A **Project:** Estimated using default land-use conversion factors for non-project land	Reforestation Projects on land currently used for grazing or growing crops may cause displacement of these activities to other lands, leading to a reduction in carbon stocks on those lands (e.g., due to clearing of trees and shrubs). The shift may be either a market or physical response to the project activity. Emission associated with shifting land uses are estimated using default "leakage" factors, as detailed in Figure 6.1.
RF-14	Biological emissions/ removals from changes in harvesting on forestland outside the Project Area	Source / Sink	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Reforestation Projects will tend to increase harvesting levels relative to the baseline, potentially causing other landowners to reduce harvesting in response to increased wood product supply. The reduction in harvesting may lead to increased carbon stocks on other lands. Carbon stock increases on other lands are excluded from the GHG Assessment Boundary, however, because it is not possible to ensure their permanence. Reforestation Projects are not expected to cause an increase in harvesting on other lands (except where clearing is involved for other land uses, per SSR RF-13), so this potential effect is also excluded

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
						from the GHG Assessment Boundary.
RF-15	Combustion emissions from production, transportation, and disposal of forest products	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	This protocol assumes that combustion emissions will be controlled under a regulatory cap-and-trade program in the near future. Thus, for most of a Forest Project's duration, changes in activity due to the project will have no effect on total net emissions due to production, transportation, and disposal of forest products. These emissions are therefore excluded from the GHG Assessment Boundary.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related CH_4 emissions related to changes in the production, transportation, and disposal of forest products are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related N_2O emissions related to changes in the production, transportation, and disposal of forest products are not considered significant.
RF-16	Combustion emissions from production, transportation, and disposal of alternative materials to forest products	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in forest-product production may cause consumers of these products to increase or decrease their consumption of substitute materials (such as alternative building materials, including cement or steel). In many cases, alternative materials will have higher combustion GHG emissions associated with their production, transportation, and/or disposal than wood products. This protocol assumes, however, that combustion emissions will be controlled under a regulatory cap-and-trade program in the near future. Thus, for most of a Forest Project's duration, changes in activity due to the project will have no effect on total net emissions due to production, transportation, and disposal of alternative materials. These emissions are therefore excluded from the GHG Assessment Boundary.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related CH_4 emissions related to changes in the production, transportation, and disposal of alternative materials are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related N_2O emissions related to changes in the production, transportation, and disposal of alternative materials are not considered significant.

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
RF-17	Biological emissions from decomposition of forest products	Source	CO_2	*Included*	**Baseline:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR RF-7) and landfills (SSR RF-8) **Project:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR RF-7) and landfills (SSR RF-8)	CO_2 emissions from the decomposition of forest products are built into calculations of how much forest product carbon will remain in in-use wood products and in landfills, averaged over 100 years (see SSR RF-7 and Quantification Guidance on the FPP webpage).
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	In-use wood products will produce little to no CH_4 emissions. CH_4 emissions can result from anaerobic decomposition of forest products in landfills. This protocol assumes that landfill CH_4 emissions will be largely controlled in the near future due to federal and/or state regulations. Thus, changes in forest-product production are assumed to have no significant effect on future CH_4 emissions from anaerobic decomposition of forest products in landfills. These emissions are therefore excluded from the GHG Assessment Boundary.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Decomposition of forest is not expected to be a significant source of N_2O emissions.

5.2 Improved Forest Management Projects

Table 5.2. GHG Assessment Boundary – Improved Forest Management Projects

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
Primary Effect Sources, Sinks, and Reservoirs						
IFM-1	Standing live carbon (carbon in all portions of living trees)	Reservoir / Pool	CO_2	*Included*	**Baseline:** Modeled based on initial field inventory measurements, regulatory environment, and financial feasibility **Project:** Measured by field measurements and updating forest carbon inventory	Increases in standing live carbon stocks are likely to be the largest Primary Effect of Improved Forest Management Projects.
IFM-2	Shrubs and herbaceous understory carbon	Reservoir / Pool	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Shrubs and herbaceous understory constitute a relatively small proportion of carbon stocks in an Improved Forest Management project.

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
IFM-3	Standing dead carbon (carbon in all portions of dead, standing trees)	Reservoir / Pool	CO_2	*Included*	**Baseline:** Assumed to be static based on initial field inventory measurements **Project:** Measured by updating forest carbon inventory	Improved Forest Management Projects may significantly increase standing dead carbon stocks over time. The protocol requires recruitment and retention of dead material, including standing dead wood as a structural element. Minimum volume thresholds are stated to meet Natural Forest Management criteria. (See Section 3.9.2).
IFM-4	Lying dead wood carbon	Reservoir / Pool	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Lying dead wood is highly variable and it is therefore difficult to achieve accurate estimates. It also constitutes a minor portion of forest carbon. With required retention for Natural Forest Management (see below), it is a conservative programmatic measure not to include it. For Natural Forest Management criteria, the protocol requires recruitment and retention of dead material, including lying dead wood as a structural element. Minimum volume thresholds are stated to meet Natural Forest Management criteria. (See Section 3.9.2).
IFM-5	Litter and duff carbon (carbon in dead plant material)	Reservoir / Pool	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in this reservoir are unlikely to have a significant effect on total quantified GHG reductions/removals. It is a conservative programmatic measure not to include it.
IFM-6	Soil carbon	Reservoir / Pool	CO_2	*Included for emissions estimates*	**Baseline:** Assumed to be static with start date inventory estimates **Project:** Emissions from project activities estimated with standardized guidelines in found in the Quantification Guidance on the FPP webpage.	Soil carbon is not anticipated to change significantly as a result of most Improved Forest Management activities. However, all projects must use standardized guidance to account for potential soil carbon emissions associated with management activities.
IFM-7	Carbon in in-use forest products	Reservoir / Pool	CO_2	*Included*	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes	Included because many Improved Forest Management Projects may significantly change carbon storage in in-use forest products relative to baseline levels. Treated as a “source/sink” because forest product carbon is quantified according to the change in harvesting volumes, relative to baseline levels, in each year. Of this change (increase or decrease), only the

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
						average amount of carbon expected to remain stored for 100 years is included in the final quantification of annual net GHG removals/emissions. This approach accounts for CO_2 emissions from decomposition or disposal of wood products (see SSR IFM-17).
IFM-8	Forest product carbon in landfills	Reservoir / Pool	CO_2	*Excluded when project harvesting exceeds baseline* *Included when project harvesting is below baseline*	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes	Because of significant uncertainties associated with forecasting the quantity of forest product carbon that will remain stored in landfills, landfill carbon is excluded from quantification in years when project harvesting volumes exceed baseline volumes. Landfill carbon is included, however, in years when project harvesting volumes are below baseline levels. This case-dependent exclusion or inclusion is necessary to ensure that total GHG reductions and removals caused by the Forest Project are not overestimated.
Secondary Effect Sources, Sinks, and Reservoirs						
IFM-9	Biological emissions from site preparation activities	Source	CO_2	*Included*	**Baseline:** N/A **Project:** Quantified based on measured carbon stock changes in included reservoirs (SSR IFM-6, where applicable)	Biological emissions from site preparation are not quantified separately, but rather are captured by measuring changes in included carbon reservoirs (soil carbon, where applicable). For other carbon reservoirs, changes are unlikely to have a significant effect on total quantified GHG reductions/removals.
IFM-10	Mobile combustion emissions from site preparation activities	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Mobile combustion CO_2 emissions from site preparation are not expected to be significantly different from baseline levels for Improved Forest Management Projects. In addition, this protocol assumes that combustion emissions in the U.S. will be controlled under a regulatory cap-and-trade program in the near future, meaning that changes in activity due to the Forest Project will have no effect on total net emissions.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in CH_4 emissions from mobile combustion associated with site preparation activities are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in N_2O emissions from mobile combustion associated

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
						with site preparation activities are not considered significant.
IFM-11	Mobile combustion emissions from ongoing project operation and maintenance	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Mobile combustion CO_2 emissions from ongoing project operation and maintenance are unlikely to be significantly different from baseline levels, and are therefore not included in the GHG Assessment Boundary. In addition, this protocol assumes that such emissions will be controlled under a regulatory cap-and-trade program in the near future, meaning that changes in activity due to the Forest Project will have no effect on total net emissions.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in CH_4 emissions from mobile combustion associated with ongoing project operation and maintenance activities are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in N_2O emissions from mobile combustion associated with ongoing project operation and maintenance activities are not considered significant.
IFM-12	Stationary combustion emissions from ongoing project operation and maintenance	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Stationary combustion CO_2 emissions from ongoing project operation and maintenance could include GHG emissions associated with electricity consumption or heating/cooling at Project Operator facilities, or at facilities owned or controlled by contractors. These emissions are unlikely to be significantly different from baseline levels, and are therefore not included in the GHG Assessment Boundary. In addition, this protocol assumes that such emissions will be controlled under a regulatory cap-and-trade program in the near future, meaning that changes in activity due to the Forest Project will have no effect on total net emissions.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in CH_4 emissions from stationary combustion associated with ongoing project operation and maintenance activities are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in N_2O emissions from stationary combustion associated with ongoing project operation and maintenance activities are not considered significant.

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
IFM-13	Biological emissions from clearing of forestland outside the Project Area	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Improved Forest Management Projects are not expected to cause significant shifts in alternative land uses that might lead to clearing of forestland.
IFM-14	Biological emissions/ removals from changes in harvesting on forestland outside the Project Area	Source / Sink	CO_2	*Included / Excluded*	**Baseline:** N/A **Project:** Estimated "leakage" factor applied to the difference in harvested carbon relative to baseline based on the magnitude of that difference relative to baseline harvest amounts	Improved Forest Management Projects may either increase or decrease harvesting relative to baseline levels. If harvesting is reduced in the Project Area, harvesting on other lands may increase to compensate for the lost production. This "leakage" effect is included in the GHG Assessment Boundary. If harvesting is increased in the Project Area, harvesting on other lands may decrease in response to the increased production. The reduction in harvesting may lead to increased carbon stocks on other lands. Carbon stock increases on other lands are excluded from the GHG Assessment Boundary, however, because it is not possible to ensure their permanence.
IFM-15	Combustion emissions from production, transportation, and disposal of forest products	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	This protocol assumes that combustion emissions will be controlled under a regulatory cap-and-trade program in the near future. Thus, for most of a Forest Project's duration, changes in activity due to the project will have no effect on total net emissions due to production, transportation, and disposal of forest products. These emissions are therefore excluded from the GHG Assessment Boundary.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related CH_4 emissions related to changes in the production, transportation, and disposal of forest products are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related N_2O emissions related to changes in the production, transportation, and disposal of forest products are not considered significant.
IFM-16	Combustion emissions from production, transportation, and disposal of alternative materials to forest products	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in forest-product production may cause consumers of these products to increase or decrease their consumption of substitute materials (such as alternative building materials, including cement or steel). In many cases, alternative materials will have

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
						higher combustion GHG emissions associated with their production, transportation, and/or disposal than wood products. This protocol assumes, however, that combustion emissions will be controlled under a regulatory cap-and-trade program in the near future. Thus, for most of a Forest Project's duration, changes in activity due to the project will have no effect on total net emissions due to production, transportation, and disposal of alternative materials. These emissions are therefore excluded from the GHG Assessment Boundary.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related CH_4 emissions related to changes in the production, transportation, and disposal of alternative materials are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related N_2O emissions related to changes in the production, transportation, and disposal of alternative materials are not considered significant.
IFM-17	Biological emissions from decomposition of forest products	Source	CO_2	*Included*	**Baseline:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR IFM-7) and landfills (SSR IFM-8) **Project:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR IFM-7) and landfills (SSR IFM-8)	CO_2 emissions from the decomposition of forest products are built into calculations of how much forest product carbon will remain in in-use wood products and in landfills, averaged over 100 years (see SSR IFM-7 and Quantification Guidance on the FPP webpage).
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	In-use wood products will produce little to no CH_4 emissions. CH_4 emissions can result from anaerobic decomposition of forest products in landfills. This protocol assumes that landfill CH_4 emissions will be largely controlled in the near future due to federal and/or state regulations. Thus, changes in forest-product production are assumed to have no significant effect on future CH_4 emissions

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
						from anaerobic decomposition of forest products in landfills. These emissions are therefore excluded from the GHG Assessment Boundary.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Decomposition of forest is not expected to be a significant source of N_2O emissions.

5.3 Avoided Conversion Projects

Table 5.3. GHG Assessment Boundary – Avoided Conversion Projects

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
Primary Effect Sources, Sinks, and Reservoirs						
AC-1	Standing live carbon (carbon in all portions of living trees)	Reservoir / Pool	CO_2	*Included*	**Baseline:** Modeled based on initial field inventory measurements and expected land-use conversion rates **Project:** Measured by field measurements and updating forest carbon inventory	Preservation and/or increases of standing live carbon stocks and/or soil carbon stocks relative to baseline levels are likely to be a large Primary Effect of Avoided Conversion Projects.
AC-2	Shrubs and herbaceous understory carbon	Reservoir / Pool	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in this reservoir/reservoir are unlikely to have a significant effect on total quantified GHG reductions/removals. Additionally, it is a conservative programmatic measure to exclude shrubs and herbaceous understory carbon.
AC-3	Standing dead carbon (carbon in all portions of dead, standing trees)	Reservoir / Pool	CO_2	*Included*	**Baseline:** Assumed to be static based on initial field inventory measurements **Project:** Measured by updating forest carbon inventory	Avoided Conversion Projects may significantly increase standing dead carbon stocks over time. The protocol requires recruitment and retention of dead material, including standing dead wood as a structural element. Minimum volume thresholds are stated to meet Natural Forest Management criteria. (See Section 3.9.2).
AC-4	Lying dead wood carbon	Reservoir / Pool	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Exclusion of lying dead wood is programmatically conservative for accounting of total quantified GHG reductions/removals, since project activities most likely will lead to increases in lying dead wood carbon. Lying dead wood is highly variable and is difficult to measure accurately, and therefore challenging to achieve confidence with estimates

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
						For Natural Forest Management criteria, the protocol requires recruitment and retention of dead material, including lying dead wood as a structural element. Minimum volume thresholds are stated to meet Natural Forest Management criteria. (See Section 3.9.2).
AC-5	Litter and duff carbon (carbon in dead plant material)	Reservoir / Pool	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Exclusion of litter and duff carbon is programmatically conservative for accounting of total quantified GHG reductions/removals, since project activities most likely will lead to increases in litter and duff carbon. Litter and duff is highly variable, difficult to measure accurately, and therefore challenging to achieve confidence with estimates.
AC-6	Soil carbon	Reservoir / Pool	CO_2	*Optional for reporting project benefits* *Included for reporting project emissions*	**Baseline:** When included, assumed to have emissions and emission rates according to soil order and baseline conversion activity **Project:** Emissions calculated using standardized guidance in the Soil Quantification Guidance on the FPP webpage. Project Operators may opt to quantify net removals or avoided emissions by updating forest soil carbon inventory	Soil carbon is likely a large primary effect of an Avoided Conversion Project. It is conservative to exclude the conversion effect on soil from the project accounting, which is why it is optional. All projects must use standardized guidance to account for potential soil carbon emissions associated with project management activities. If Project Operators choose to quantify net removals or avoided emissions from soil carbon, they may do so by undertaking and updating a soil carbon inventory.
AC-7	Carbon in in-use forest products	Reservoir / Pool	CO_2	*Included*	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes	Included because many Avoided Conversion Projects may significantly change carbon storage in in-use forest products relative to baseline levels. Treated as a "source/sink" because forest product carbon is quantified according to the change in harvesting volumes, relative to baseline levels, in each year. Of this change (increase or decrease), only the average amount of carbon expected to remain stored for 100 years is included in the final quantification of annual net GHG removals/emissions. This approach accounts for CO_2 emissions from decomposition or disposal of wood products (see SSR AC-17).
AC-8	Forest product carbon in landfills	Reservoir / Pool	CO_2	*Excluded when project harvesting exceeds baseline*	**Baseline:** Estimated from modeled harvesting volumes	Because of significant uncertainties associated with forecasting the quantity of forest product carbon that will remain stored in landfills, landfill carbon is excluded from quantification in years when project harvesting volumes

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
				Included when project harvesting is below baseline	**Project:** Estimated from measured harvesting volumes	exceed baseline volumes. Landfill carbon is included, however, in years when project harvesting volumes are below baseline levels. This case-dependent exclusion or inclusion is necessary to ensure that total GHG reductions and removals caused by the Forest Project are not overestimated.
Secondary Effect Sources, Sinks, and Reservoirs						
AC-9	Biological emissions from site preparation activities	Source	CO_2	*Included*	**Baseline:** N/A **Project:** Quantified based on measured carbon stock changes in included reservoirs (SSR AC-6, where applicable)	Biological emissions from site preparation are not quantified separately, but rather are captured by measuring changes in included carbon reservoirs (soil carbon, where applicable). For other carbon reservoirs, changes are unlikely to have a significant effect on total quantified GHG reductions/removals.
AC-10	Mobile combustion emissions from site preparation activities	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Mobile combustion CO_2 emissions from site preparation (including land-use conversion activities) are likely to be higher in the baseline than under project. These emissions are therefore excluded from the GHG Assessment Boundary in order to be conservative. In addition, this protocol assumes that combustion emissions in the United States will be controlled under a regulatory cap-and-trade program in the near future, meaning that changes in activity due to the Forest Project will have no effect on total net emissions.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Differences in CH_4 emissions from mobile combustion associated with site preparation activities are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Differences in N_2O emissions from mobile combustion associated with site preparation activities are not considered significant.
AC-11	Mobile combustion emissions from ongoing project operation and maintenance	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Mobile combustion CO_2 emissions from ongoing project operation and maintenance are unlikely to be significantly different from baseline levels, and are therefore not included in the GHG Assessment Boundary. In addition, this protocol assumes that such emissions will be controlled under a regulatory cap-and-trade program in the near future, meaning that changes in activity due to the Forest Project will have no effect on total net emissions.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in CH_4 emissions from mobile combustion associated with ongoing project operation and maintenance activities are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A	Changes in N_2O emissions from mobile combustion associated with ongoing

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
					Project: N/A	project operation and maintenance activities are not considered significant.
AC-12	Stationary combustion emissions from ongoing project operation and maintenance	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Stationary combustion CO_2 emissions from ongoing project operation and maintenance could include GHG emissions associated with electricity consumption or heating/cooling at Project Operator facilities, or at facilities owned or controlled by contractors. These emissions are unlikely to be significantly different from (or will be lower than) baseline levels and are therefore not included in the GHG Assessment Boundary. In addition, this protocol assumes that such emissions will be controlled under a regulatory cap-and-trade program in the near future, meaning that changes in activity due to the Forest Project will have no effect on total net emissions.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in CH_4 emissions from stationary combustion associated with ongoing project operation and maintenance activities are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in N_2O emissions from stationary combustion associated with ongoing project operation and maintenance activities are not considered significant.
AC-13	Biological emissions from clearing of forestland outside the Project Area	Source	CO_2	*Included*	**Baseline:** N/A **Project:** Estimated using default forestland conversion factors	Avoided Conversion Projects may cause land-use pressures to shift to other forestlands, causing biological emissions that partially negate the benefits of the project.
AC-14	Biological emissions/ removals from changes in harvesting on forestland outside the Project Area	Source / Sink	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Over time, Avoided Conversion Projects will tend to increase harvesting levels relative to the baseline, potentially causing other landowners to reduce harvesting in response to increased wood product supply. The reduction in harvesting may lead to increased carbon stocks on other lands. Carbon stock increases on other lands are excluded from the GHG Assessment Boundary, however, because it is not possible to ensure their permanence. Avoided Conversion Projects are not expected to cause an increase in harvesting on other lands over the long run (except where clearing is involved for other land uses, per SSR AC-13), so this potential effect is also excluded from the GHG Assessment Boundary.
AC-15	Combustion emissions from production, transportation,	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	This protocol assumes that combustion emissions will be controlled under a regulatory cap-and-trade program in the near future. Thus, for most of a Forest

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
	and disposal of forest products					Project's duration, changes in activity due to the project will have no effect on total net emissions due to production, transportation, and disposal of forest products. These emissions are therefore excluded from the GHG Assessment Boundary.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related CH_4 emissions related to changes in the production, transportation, and disposal of forest products are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related N_2O emissions related to changes in the production, transportation, and disposal of forest products are not considered significant.
AC-16	Combustion emissions from production, transportation, and disposal of alternative materials to forest products	Source	CO_2	*Excluded*	**Baseline:** N/A **Project:** N/A	Changes in forest-product production may cause consumers of these products to increase or decrease their consumption of substitute materials (such as alternative building materials, including cement or steel). In many cases, alternative materials will have higher combustion GHG emissions associated with their production, transportation, and/or disposal than wood products. This protocol assumes, however, that combustion emissions will be controlled under a regulatory cap-and-trade program in the near future. Thus, for most of a Forest Project's duration, changes in activity due to the project will have no effect on total net emissions due to production, transportation, and disposal of alternative materials. These emissions are therefore excluded from the GHG Assessment Boundary.
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related CH_4 emissions related to changes in the production, transportation, and disposal of alternative materials are not considered significant.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Combustion-related N_2O emissions related to changes in the production, transportation, and disposal of alternative materials are not considered significant.
AC-17	Biological emissions from decomposition of forest products	Source	CO_2	*Included*	**Baseline:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR AC-7) and landfills (SSR AC-8) **Project:** Quantified as a component of calculating carbon	CO_2 emissions from the decomposition of forest products are built into calculations of how much forest product carbon will remain in in-use wood products and in landfills, averaged over 100 years (see SSR AC-7 and Quantification Guidance on the FPP webpage).

SSR	Description	Type	Gas	Included or Excluded	Relevant to Baseline or Project	Justification/Explanation
					stored for 100 years in wood products (SSR AC-7) and landfills (SSR AC-8)	
			CH_4	*Excluded*	**Baseline:** N/A **Project:** N/A	In-use wood products will produce little to no CH_4 emissions. CH_4 emissions can result from anaerobic decomposition of forest products in landfills. This protocol assumes that landfill CH_4 emissions will be largely controlled in the near future due to federal and/or state regulations. Thus, changes in forest-product production are assumed to have no significant effect on future CH_4 emissions from anaerobic decomposition of forest products in landfills. These emissions are therefore excluded from the GHG Assessment Boundary.
			N_2O	*Excluded*	**Baseline:** N/A **Project:** N/A	Decomposition of forest is not expected to be a significant source of N_2O emissions.

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 ISO-accredited and Reserve-approved verification body that the Forest Project's GHG reductions and removals have been quantified following the applicable requirements of this section (see Section 9 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 Project Operator 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). 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 described in the Quantification Guidance on the FPP webpage. Modeling of onsite carbon stocks over time must be conducted following the requirements in this section and the guidance in the Quantification Guidance. 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, except for reconciliation of project baselines to changes in inventory estimates associated with inventory methodology updates.
2. **Estimating baseline carbon in harvested wood products.** In conjunction with modeling baseline onsite carbon stocks, the Project Operator must forecast any harvesting that would have occurred in the baseline and convert this to an average annual harvesting volume. From this, the Project Operator 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 the Quantification Guidance.
3. **Determining actual onsite carbon stocks.** Each year, the Project Operator 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 the Quantification Guidance. The estimate of actual onsite carbon stocks must be adjusted by an appropriate confidence deduction, as described in the Quantification Guidance.
4. **Determining actual carbon in harvested wood products.** Each year, the Project Operator 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 available in the Quantification Guidance.
5. **Calculating the project's Primary Effect.** Each year, the Project Operator must quantify the actual change in GHG emissions or removals associated with the Forest Project's intended ("Primary") effect, as defined in Section 5. For any given year, the Primary Effect is calculated by:

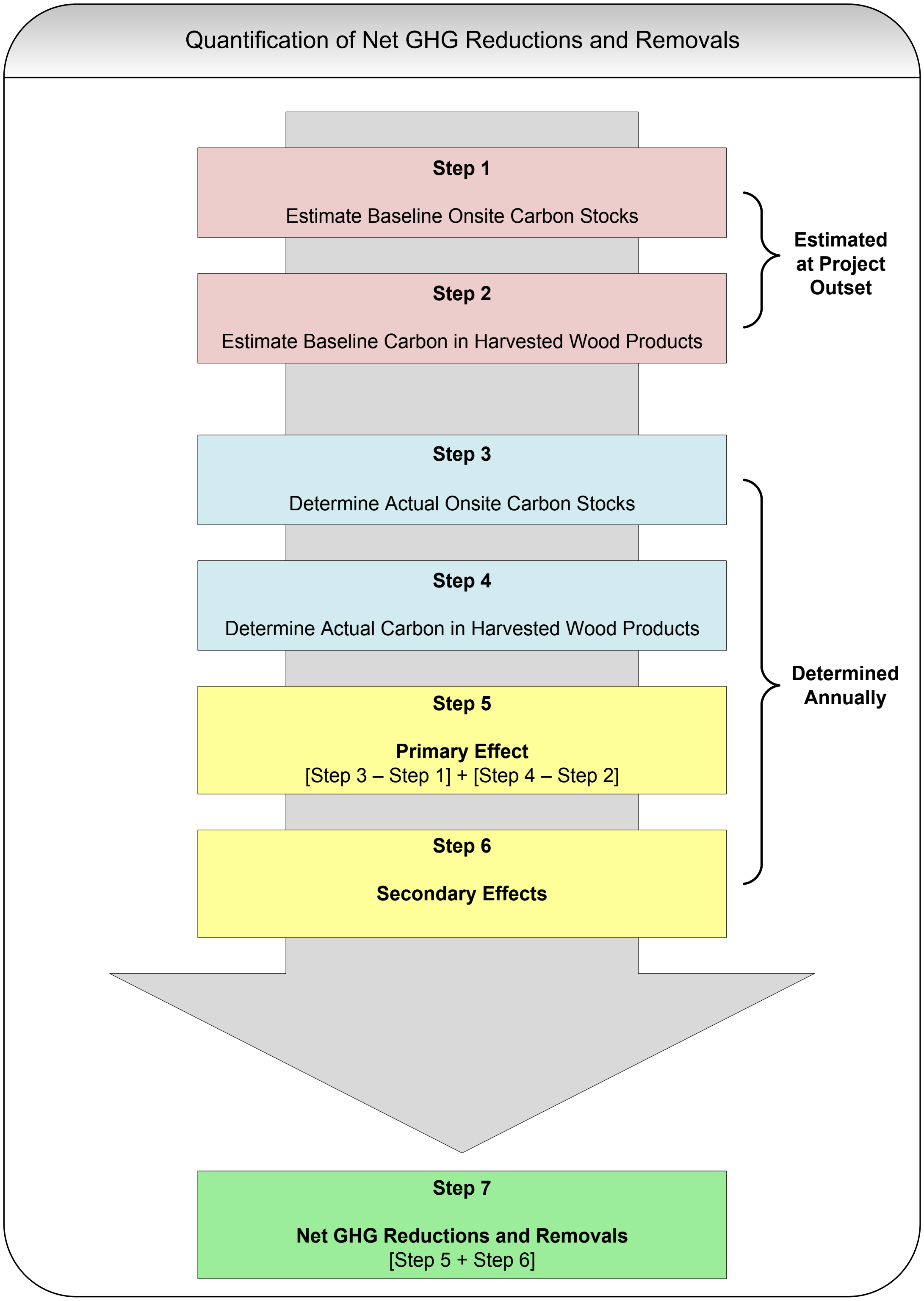
a. Taking the difference between actual onsite carbon stocks for the current year and actual onsite carbon stocks for the prior year[13]
b. Subtracting from (a) the difference between baseline onsite carbon stocks for the current year and baseline onsite carbon stocks for the prior year[14]
c. Adding 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.** Each year, the Project Operator must quantify the actual change in GHG emissions or removals associated with the Forest Project's unintended ("Secondary") effects, as defined in Section 5. Requirements and guidance for quantifying Secondary Effects are provided below for each type of Forest 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 result is negative, this may indicate a reversal has occurred (see Section 7).[15]

Requirements and guidance for how to perform quantification steps 1 to 4 for each Forest Project type are presented in the remainder of this section.

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 tons.

[13]For the purposes of calculating the project's Primary Effect, actual and baseline carbon stocks prior to the start date of the project are assumed to be zero.
[14] See footnote 13.
[15] A reversal occurs only if: (1) total net GHG reductions and removals for the year are negative; and (2) CRTs have previously been issued to the Forest Project. If calculated GHG reductions and removals are negative and no CRTs have been issued to the project since its start date, then the result should be treated as a "negative carryover" to GHG reduction calculations in subsequent years (variable N_{y-1} in Equation 6.1). This may happen, for example, because the confidence deduction applied to actual onsite carbon stocks can result in actual values being less than baseline values in a Forest Project's initial years.


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. Annual Net GHG Reductions and Removals

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

Where,			Units
QR_y	=	Quantified GHG reductions and removals for year y	CO_2e
$AC_{wp,\,y}$	=	Actual carbon in wood products produced in year y that is projected to remain stored for at least 100 years (i.e., $WP_{total,\,y}$ derived for actual harvest volumes following the guidance in the Quantification Guidance)	CO_2e
$BC_{wp,y}$	=	Annual baseline carbon in wood products that would have remained stored for at least 100 years (i.e., $WP_{total,\,y}$ derived for baseline harvest volumes following the guidance in the Quantification Guidance)	CO_2e
SE_y	=	Secondary Effect GHG emissions caused by the project activity in year y	CO_2e
N_{y-1}	=	Any negative carryover from the prior year (occurs when total quantified GHG reductions are negative prior to the issuance of any CRTs for the project– see footnote 15, p. 44)	CO_2e

And,

$$\Delta AC_{onsite} = \left(AC_{onsite,y}\right)\left(1 - CD_y\right) - \left(AC_{onsite,y-1}\right)\left(1 - CD_{y-1}\right)$$

Where,			
$AC_{onsite,\,y}$	=	Actual onsite carbon as inventoried for year y (y may be less than a year for the first reporting period following the start date)	CO_2e
$AC_{onsite,\,y-1}$	=	Actual onsite carbon as inventoried for year y-1	CO_2e
CD_y	=	Appropriate confidence deduction for year y, as determined following the Quantification Guidance	%
CD_{y-1}	=	Appropriate confidence deduction for year y-1, as determined following the Quantification Guidance	%

And,

$$\Delta BC_{onsite} = \left(BC_{onsite,y}\right) - \left(BC_{onsite,y-1}\right)$$

Where,			
$BC_{onsite,\,y}$	=	Baseline onsite carbon as estimated for year y (y may be less than a year for the first reporting period following the start date)	CO_2e
$BC_{onsite,\,y-1}$	=	Baseline onsite carbon as estimated for year y-1	CO_2e

Note: The term SE_y in Equation 6.1 reflects market responses to changes in wood-product production. The general assumption in this protocol is that modifying harvest in a Forest Project relative to baseline harvesting levels will lead the market to compensate via modifications to harvesting levels by other landowners. The greater the change in harvest by a Forest Project relative to baseline levels, the greater the response by the market to compensate. Section 6.2.6 describes in detail the calculation required to account for such market responses.[16]

[16] For conservativeness and ease of accounting, these wood-product market "leakage" effects are ignored for Reforestation Projects and Avoided Conversion Projects, since overall these projects will tend to result in increased harvesting relative to the baseline. Market leakage effects are accounted for under Improved Forest Management Projects, however, as described in Section 6.2.6.

6.1 Reforestation Projects

6.1.1 Estimating Baseline Onsite Carbon Stocks

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

1. Provide a qualitative characterization of the likely vegetative conditions and activities that would have occurred without 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. The qualitative assessment must be used as the basis for modeling baseline carbon stocks (step 3).
2. Inventory carbon stocks affected by site preparation prior to any site preparation activities, following the Quantification Guidance for sampling carbon pools affected by site preparation for Reforestation Projects.

   For carbon stocks not affected by site preparation, the inventory may be deferred, as described below.
3. Perform a computer simulation, once an inventory is obtained, that models the carbon stocks (from required and any selected optional pools) for 100 years following the project's start date, based on the qualitative characterization of what would have occurred without the project. The Project Operator must follow the requirements and guidance for modeling contained in the Quantification Guidance, incorporating any conditions and constraints specified in the qualitative characterization of the baseline (step 1, above). The computer simulation must model the expected growth in carbon stocks associated with pre-existing trees in the Project Area (i.e., those not planted as part of the Forest Project).

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. By the second site visit verification, the Project Operator must provide an estimated inventory of all required carbon stocks by using an approved growth model or a stand table projection methodology, as described in the Quantification Guidance, to derive an estimate of standing live carbon stocks in pre-existing trees (i.e., those not planted as part of the Forest Project) at the time of the Forest Project's start date. The Project Operator must demonstrate that applying the approved growth model or stand table projection to the estimated tree records representing the start date condition produces a result within five percent of current inventory data for pre-existing trees.

If the inventory of these carbon pools is deferred, the timing of the second site visit verification is at the discretion of the Project Operator (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 where the start date inventory and the current inventory as of the second site visit verification are verified.

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 the Quantification Guidance) to determine the *average* amount of carbon in standing live carbon stocks (prior to delivery to a mill) that would have been harvested in each year of the baseline over 100 years. The result will be a uniform estimate of harvested carbon in each year of the baseline. This estimate is determined at the project outset, using the same biomass equations used to calculate biomass in live trees, and will not change over the course of the project.
2. On an annual basis, determine the amount of harvested carbon that would have remained stored in wood products, averaged over 100 years, following the requirements in the Quantification Guidance.

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 the Quantification Guidance. Guidance for projecting forest inventory plot data using models is also provided in the Quantification Guidance.
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 the Quantification Guidance.

6.1.4 Determining Actual Carbon in Harvested Wood Products

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

1. Determine the actual amount of carbon in standing live carbon stocks (prior to delivery to a mill) harvested in the current year (based on harvest volumes determined in Section 6.1.3).
2. Determine the amount of actual harvested carbon that will remain stored in wood products, averaged over 100 years, following the requirements in the Quantification Guidance.

6.1.5 Quantifying Secondary Effects

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

1. Combustion emissions associated with machinery use in site preparation.
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, Project Operators must use the appropriate standard emission factor from Table 6.1 corresponding to the level of brush cover associated with the site preparation area, multiplied by the number of acres treated (Equation 6.2).

Mobile combustion emissions must be added to Secondary Effect emissions (SE_y in Equation 6.1) in the first reporting period 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. Combustion Emissions Associated with Site Preparation

$$\boldsymbol{MC_y = (-1)\times (EF_{mc}\times PA)}$$

Where,

			Units
MC_y	=	Secondary Effect emissions due to mobile combustion from site preparation	CO_2e
EF_{mc}	=	Mobile combustion emission factor from Table 6.1	CO_2e
PA	=	Size of the site preparation area	acres

Table 6.1. Mobile Combustion Emissions for Reforestation Projects

Site Prep - Reforestation Projects		
Emissions Associated with Mobile Combustion Average Metric Tons CO_2 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, Project Operators must determine the appropriate "leakage" risk percentage for the project following the decision tree in Figure 6.1. The leakage risk percentage must only be determined once, at the outset of the project. Each year, this percentage must be applied to 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. Emissions from Shifting Cropland and Grazing Activities

$$\boldsymbol{AS_y = (-1)\times L\times (\Delta AC_{onsite} - \Delta BC_{onsite})}$$

Where,

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

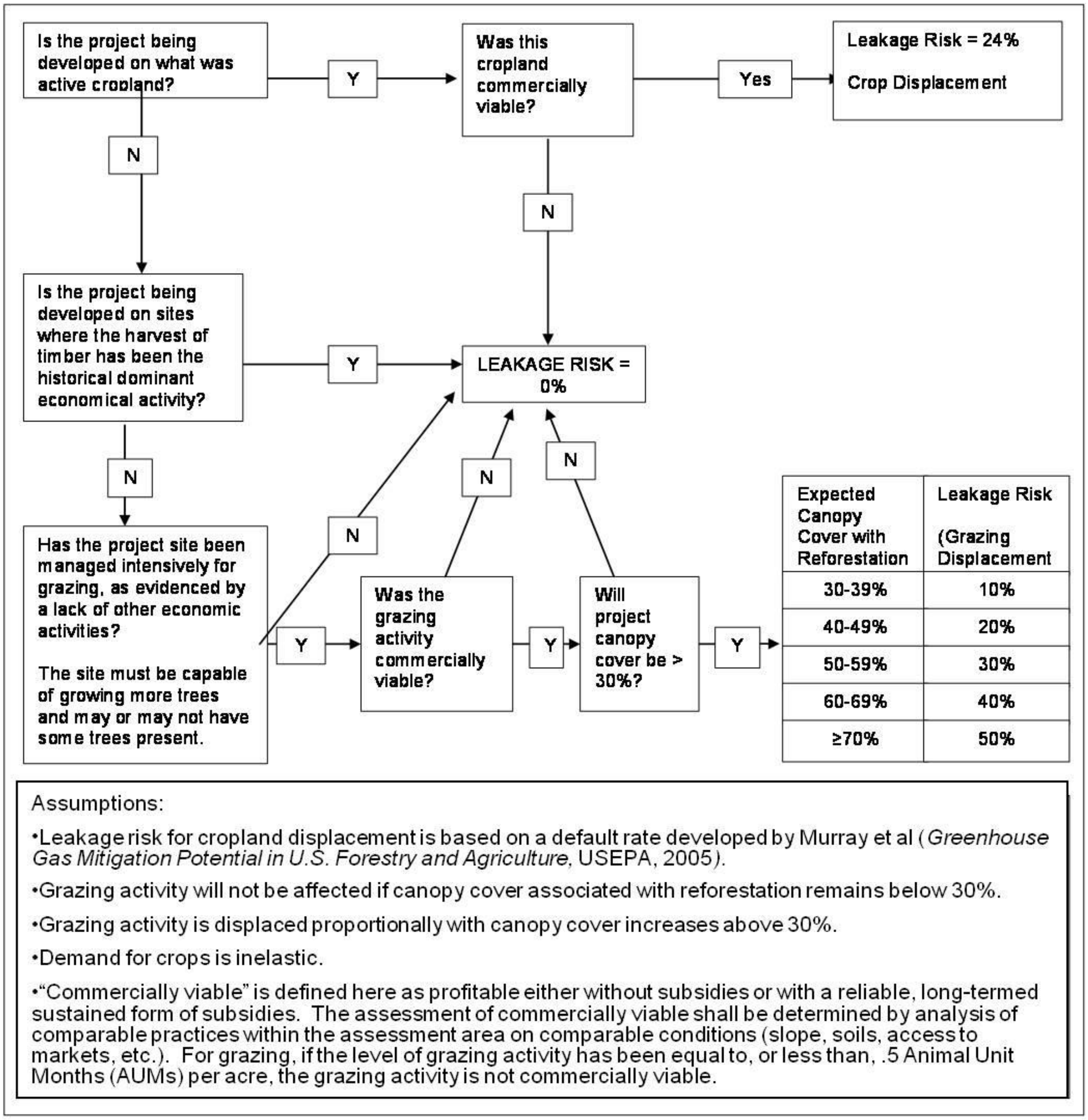


Figure 6.1. Activity Shifting ("Leakage") Risk Assessment for Reforestation Projects

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. Total Secondary Effect Emissions

$$SE_y = \left(AS_y + MC_y\right) \textbf{ or 0, whichever is lower}$$

Where,

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

6.2 Improved Forest Management Projects

Improved Forest Management Projects that take place on private land – or on land that is transferred to public ownership at the time the project is initiated – must estimate baseline onsite carbon stocks following the requirements and procedures in Section 6.2.1. Improved Forest Management Projects that take place on land that was publicly owned prior to the project start date must estimate baseline onsite carbon stocks following the requirements and procedures in Section 6.2.2. 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.

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

1. Determine the inventories of aboveground standing live carbon stocks, belowground standing live carbon stocks, and aboveground and belowground standing dead carbon stocks for the Project Area.
2. Model a 100-year growth and harvest regime reflecting legal and financial constraints. The result is a *preliminary unadjusted baseline* for carbon stocks that reasonably reflects the harvesting opportunities present within the Project Area.
3. Standardize the *preliminary unadjusted baseline* for aboveground standing live carbon stocks by averaging the annual values or, if legal constraints require stocks to increase over time, constructing an upward sloping straight line to the apex of the legal constraints and averaging annual values thereafter. Baseline carbon stocks for other carbon pools must be similarly standardized. This results in the *standardized unadjusted baseline* for reported carbon stocks.
4. Apply performance standard criteria to adjust the aboveground standing live portion of the *standardized unadjusted baseline*. The result is a *standardized adjusted baseline* for aboveground standing live carbon stocks.
5. Proportionally adjust other reported carbon stocks to match the *standardized adjusted baseline* for aboveground standing live carbon stocks.
6. Combine the results of Step 4 and Step 5 to produce the *final baseline* for all onsite carbon stocks.

For all calculations in this section, all values for “carbon stocks” should be expressed in metric tons of CO_2-equivalent.

Step 1 – Inventory Carbon Stocks within the Project Area

The start date inventory of standing live aboveground carbon stocks, separated into aboveground and belowground portions, and the start date inventory of standing dead carbon stocks, with aboveground and belowground portions combined, must be determined following the Reserve’s Quantification Guidance.

In the formulas throughout this section, initial carbon stocks are denoted by the variable PUB_0 (i.e., the *preliminary unadjusted baseline* at time zero).

Step 2 – Model Growth and Harvesting Over 100 Years

The *preliminary unadjusted baseline* for onsite carbon stocks must be estimated through a modeling exercise. The modeling exercise must use the inventories of the carbon from Step 1 as a starting point for modeling. The *preliminary unadjusted baseline* will consist of each of the following carbon pools that are maintained separately during this stage of baseline development:

- Aboveground standing live
- Belowground standing live
- Standing dead (aboveground and belowground)
- Harvested aboveground and belowground standing live
- Bole portion of harvested aboveground and belowground standing live

To determine the *preliminary unadjusted baseline,* model the initial inventory of *aboveground* standing live carbon stocks through a series of growth and harvesting scenarios over a 100-year timeframe. Modeling must be conducted using an approved growth model, as identified in the Modeling Carbon Stocks section of the Quantification Guidance. Modeling of the growth and harvesting scenarios must reflect all legal requirements that constrain the ability to harvest carbon stocks. In addition, harvesting assumptions must reflect realistic financial constraints.

Standing dead carbon stocks shall be assumed to remain static throughout the modeling process. Exceptions may be provided, at the Reserve's discretion, if compelling justification can be provided that standing dead carbon stocks are likely to fluctuate substantially as part of the project's baseline.

Step 3 - Modeling Legal Constraints

All legal constraints that affect the ability to manage carbon stocks must be included in the model design. The *preliminary unadjusted baseline* must represent a growth and harvesting regime that fulfills all legal requirements. Voluntary agreements that can be rescinded, such as rental contracts and forest certifications, are not legal constraints. Habitat Conservation Plans (HCPs) and Safe Harbor Agreements (SHAs) that are in place more than one year prior to the project's start date shall be modeled as legal constraints. HCPs and SHAs that are approved after the date one year prior to the project's start date are not considered legal constraints for baseline modeling and may be disregarded.

Legal constraints include all laws, regulations, and legally-binding commitments applicable to the Project Area at the time of the project's initiation that could affect 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
    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, HCPs, SHAs, 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 3.7.

For Forest Projects located in California, the *preliminary unadjusted baseline* must be modeled to reflect all silvicultural treatments associated with timber harvest plans (THPs) active within the Project Area at the time of the project's initiation. All legally enforceable silvicultural and operational provisions of a THP – including those operational provisions designed to meet California Forest Practice Rules requirements for achieving Maximum Sustained Production of High Quality Wood Products [14 CCR 913.11 (933.11, 953.11)] – are considered legal constraints and must be reflected in baseline modeling for if the THP will remain active. For portions of the Project Area not subject to THPs (or over time periods for which THPs will not be active), baseline carbon stocks must be modeled by considering any applicable requirements of the California Forest Practice Rules and all other applicable laws, regulations, and legally binding commitments that could affect onsite carbon stocks. On a case-by-case basis, the California Department of Forestry and Fire Protection (CAL FIRE) may assist Project Operators in identifying minimum carbon stocking levels that would be effectively required under California Forest Practice Rules.

Step 4 - Modeling Financial Constraints

Harvest assumptions included in the model must be financially viable. The Project Operator must demonstrate that the growth and harvesting regime assumed for the *preliminary unadjusted baseline* is financially feasible through 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.

A financially viable project is defined in this protocol as a project that has a net present value of at least $0 using a discount rate of 4%. This would indicate a management regime that does not lose money in the practice of performing long-term forest management activities, including road management, watercourse restoration, fuels management, etc. Inputs to the analysis include the volume of species harvested, logging and hauling costs, delivered log prices, and forest management costs. A calculation workbook for this analysis will be made available by the Reserve, but use of this tool is optional.

Step 5 - Generate a *Standardized Unadjusted Baseline*

The periodic modeled outputs from the *preliminary unadjusted baseline* must be standardized according to the following guidance for each carbon pool. The result will be a *standardized unadjusted baseline* for each carbon pool (including both aboveground and belowground portions of standing live and dead carbon stocks).

Aboveground standing live carbon stocks: The periodic modeled outputs for aboveground standing live carbon stocks must be either averaged or converted to a straight-line approximation reflective of legal constraints.

If legal constraints do *not* result in an upward trend in aboveground standing live carbon stocks, then the periodic model outputs must be averaged using Equation 6.5.

If legal constraints do result in an increasing trend of aboveground standing live carbon stocks, beginning at the project start date, then the periodic model outputs may be standardized using a straight-line approximation, as defined in Equation 6.6. The approximation must consist of two line segments. The first of the line segments must initiate at the initial inventory at the project start date and terminate at the point where carbon stocks reach their highest legally required level. The second segment is a straight line with a constant value, defined by the terminus of the first line segment, for the balance of the 100-year modeling timeframe.

Equation 6.5. Formula for Averaging *Preliminary Unadjusted Baseline* Carbon Stocks

For all years *y*, $SUB_y = \frac{\sum_{y=0}^{100} PUB_y}{100}$

Where,

			Units
SUB_y	=	*Standardized unadjusted baseline* for aboveground live carbon stocks (and other related and reported carbon stocks as shown below) value for year *y* (including the start date at y=0)	tCO_2e
PUB_y	=	*Preliminary unadjusted baseline* value for year *y*. PUB_0 represents the initial aboveground live and standing dead carbon stocks at the project start date	tCO_2e

Equation 6.6. Formula for Approximating *Preliminary Unadjusted Baseline* Carbon Stocks as a Straight-Line Trend

For years *y* < Y, $SUB_y = SS + y \times \frac{ES-SS}{Y}$

For years *y* ≥ Y, $SUB_y = ES$

Where,

			Units
SUB_y	=	*Standardized Unadjusted Baseline* value for year *y*	tCO_2e
Y	=	Time in years between the project start date and the year at which the highest legally required stocking level is reached for aboveground standing live carbon stocks. This is determined by modeling a forest growth and yield simulation that includes legal and financial constraints (in Step 2, above)	years
SS	=	Starting stocks = PUB_0	tCO_2e
ES	=	Ending stocks = The highest legally required stocking level, as determined in Step 2	tCO_2e

Belowground standing live carbon stocks: The belowground portion of the standing live carbon stocks must be standardized in the same way as the aboveground standing live carbon stocks, i.e., either averaged (Equation 6.5), or calculated with an upward-sloping line to a potential terminus (Equation 6.6).

The aboveground and belowground portions of standing dead carbon stocks: Standing dead carbon stocks shall be set at the quantity of carbon stocks present in the standing dead carbon stock pool at the project start date. Exceptions may be provided, at the Reserve's discretion, if compelling justification can be provided that standing dead carbon stocks are likely to fluctuate substantially as part of the project's baseline. Standing dead stocks are not adjusted based on adjustments to the standing live carbon stocks, but should be combined with the *standardized unadjusted baseline* for aboveground standing live carbon for the purpose of applying the performance standard criteria in Step 4 below.

Carbon stocks in the aboveground and belowground portions of standing live trees harvested for wood products: The carbon stocks shall be calculated as the average of the periodic outputs for the entire 100-year modeling if the aboveground live tree carbon stocks do not result in an upward trend.

If the carbon stocks in aboveground standing live carbon stocks results in an upward trend, the carbon stocks shall be calculated as an average from the start date to the highest point of the aboveground standing live carbon stocks. A separate average of carbon stocks in both the aboveground and belowground portions of standing live trees harvested for wood products between the highest point of the aboveground standing live carbon stocks and the end point of the 100-year modeling shall be calculated, as applicable.

Carbon stocks in the bole portion of trees harvested for wood products: The carbon stocks shall be calculated as the average of periodic outputs for the entire 100-year modeling if the aboveground live tree carbon stocks do not result in an upward trend.

For upward-sloping lines, the values shall be based on the carbon stocks harvested to the legal constraint terminus and be based on the average carbon stocks from the terminus to the balance of the 100-year modeling (if applicable).

Step 6 – Apply Performance-Standard Criteria

Once the components of the *standardized unadjusted baseline* are determined in Step 3, the aboveground standing live and standing dead components must be adjusted to conform to a set of performance standard criteria, as described below. The result is a *standardized adjusted baseline* for aboveground standing live and standing dead carbon stocks. Other reported carbon pools are adjusted in Step 5.

The performance standard criteria establish minimum aboveground standing live and standing dead carbon stock values for the baseline in each year, regardless of what is legally and financially viable. The elements of the performance standard are:

- *The High Stocking Reference:* The High Stocking Reference is a measure of carbon stocks in aboveground standing live and standing dead biomass over the 10 years preceding the project start date. It governs baseline carbon stocks in certain instances where aboveground standing live carbon stocks have declined prior to the start date. See further guidance below on how to determine the High Stocking Reference.
- *Comparison of initial carbon stocks to Common Practice*: If the *standardized unadjusted baseline* for aboveground standing live carbon stocks was averaged (i.e., it was determined according to Equation 6.5), then the *standardized adjusted baseline* may depend on how the initial carbon stocks compare to Common Practice levels (see guidance below for how to determine Common Practice). For projects whose initial carbon stocks are above Common Practice, the *standardized adjusted baseline* for aboveground standing live and standing dead carbon stocks may not be below Common Practice. For projects whose initial carbon stocks are below Common Practice, the

standardized adjusted baseline for aboveground standing live and standing dead carbon stocks may not be below either (1) the initial inventory level or (2) the High Stocking Reference, whichever is greater. See Equation 6.7 and Equation 6.8 below.

The procedure for determining the *standardized adjusted baseline* depends on whether the *standardized unadjusted baseline* for aboveground standing live carbon stocks was determined as an average (i.e., according to Equation 6.5), or an upward sloping straight-line trend (i.e., according to Equation 6.6).

Where the *standardized unadjusted baseline* for aboveground standing live carbon stocks was determined using Equation 6.5:

- If the project's initial aboveground standing live and standing dead carbon stocks (PUB_0) are above Common Practice, use Equation 6.7 to determine the *standardized adjusted baseline*
- If the project's initial aboveground standing live and standing dead carbon stocks (PUB_0) are below Common Practice, use Equation 6.8 to determine the *standardized adjusted baseline*

In both cases, values must be determined for all years, *y*, starting with zero (the start date of the project) and ending with 100.

Equation 6.7. Determining the *Standardized Adjusted Baseline* for Aboveground Live and Standing Dead Carbon Stocks Where Initial Stocks Are at or Above Common Practice

$$\boldsymbol{SAB_y = MAX\left(CP, PUB_0, SUB_y\right)}$$

Where,

			Units
SAB_y	=	*Standardized adjusted baseline* for aboveground standing live and standing dead carbon stocks value in year *y*	tCO_2e
CP	=	Common Practice (determined according to the guidance below)	tCO_2e
PUB_0	=	Initial aboveground standing live and dead carbon stocks per acre within the Project Area (as determined in Step 1)	tCO_2e /acre
SUB_y	=	Value of the *standardized unadjusted baseline* for year *y,* as determined in Step 5	tCO_2e

Equation 6.8. Determining the *Standardized Adjusted Baseline* for Aboveground Live and Standing Dead Carbon Stocks Where Initial Stocks Are Below Common Practice

$$\boldsymbol{SAB_y = MAX\left(MAX(HSR, PUB_0), MIN(CP, SUB_y)\right)}$$

Where,

			Units
SAB_y	=	*Standardized adjusted baseline* for aboveground standing live and standing dead carbon stocks value in year *y*	tCO_2e
HSR	=	"High Stocking Reference" for the Project Area. See guidance below for how the HSR is determined	tCO_2e
CP	=	Common Practice (determined according to the guidance below)	tCO_2e
PUB_0	=	Initial aboveground standing live carbon stocks per acre within the Project Area (as determined in Step 1)	tCO_2e /acre
SUB_y	=	Value of the *standardized unadjusted baseline* for year *y,* as determined in Step 5	tCO_2e

Where the *standardized unadjusted baseline* for aboveground standing live and standing dead carbon stocks was determined using Equation 6.6:

- The *standardized adjusted baseline* (SAB*y*) may be determined according to Equation 6.6, substituting SAB*y* for SUB*y* and using the formula in Equation 6.9 to determine starting stocks.

Equation 6.9. Formula for Determining Starting Stocks for the *Standardized Adjusted Baseline*

$$SS = MAX(PUB_0, HSR)$$

Where,

			Units
SS	=	Starting stocks for use in Equation 6.6	tCO_2e
PUB_0	=	Initial aboveground standing live and standing dead carbon stocks per acre within the Project Area (as determined in Step 1)	tCO_2e /acre
HSR	=	"High Stocking Reference" for the Project Area. See guidance below for how the HSR is determined	tCO_2e

Determining the High Stocking Reference

The High Stocking Reference is defined as 80 percent of the highest value for aboveground standing live carbon stocks per acre within the Project Area during the 10-year period preceding the project start date. To determine the High Stocking Reference, the Project Operator must document changes in the Project Area's aboveground standing live and standing dead carbon stocks over the 10 years prior to the initiation of the project, or for as long as the Project Operator has had control of the stocks, whichever is shorter. Figure 6.2 presents a graphical portrayal of a High Stocking Reference determination.

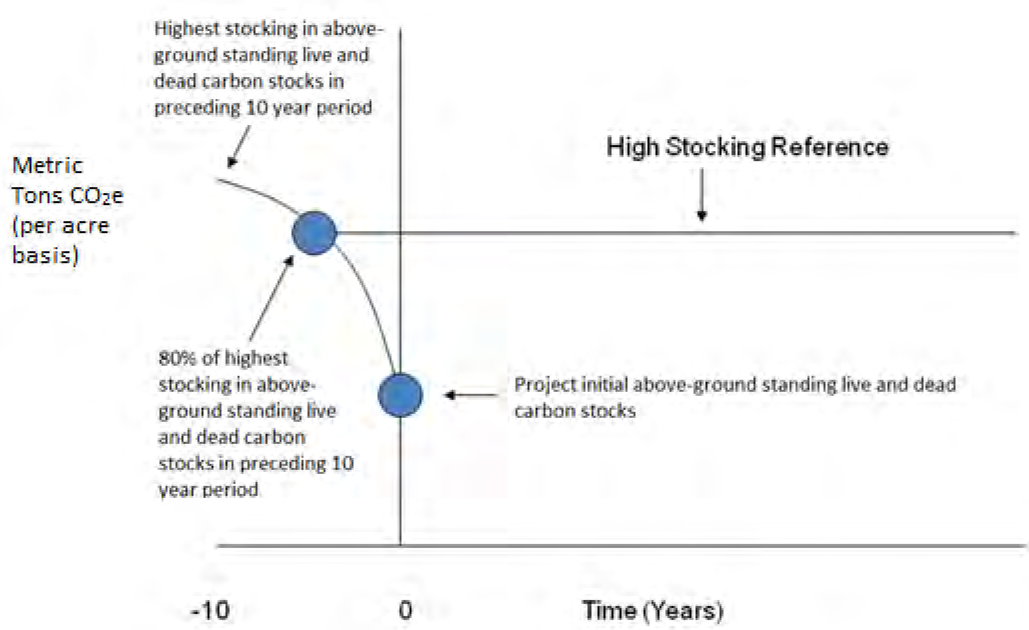


Figure 6.2. Determining a Project Area's High Stocking Reference

*It is possible for the High Stocking Reference to be higher than Common Practice, even where initial live and standing dead tree carbon stocks for the project are below Common Practice.

Determining Common Practice

Common Practice refers to the average stocks of aboveground standing live and standing dead carbon associated with the Assessment Area(s) covered by the Project Area. The Common Practice statistic applicable to a project can be found by consulting the Assessment Area Data File on the Reserve's FPP webpage. If the Project Area covers multiple Assessment Areas, Common Practice must be calculated as the average of the values for each Assessment Area, weighted by the percentage of the Project Area that falls within each Assessment Area.

Common Practice statistics are calculated from United States Forest Service Forest Inventory and Analysis (USFS FIA) program. The Reserve will update the Common Practice statistics in the Assessment Area Data File periodically. The frequency of updating Common Practice statistics will be subject to the availability of new USFS FIA data, but will be no more frequent than once every five years. The Reserve will announce any forthcoming updates to the Common Practice statistics before they are released, and any updates will not be retroactive.

Step 7 – Proportionally Adjust Other Reported Carbon Stocks

The *standardized adjusted baseline* for other reported carbon stocks must be determined by adjusting carbon stock values to reflect the *standardized adjusted baseline* for aboveground standing live and standing dead carbon stocks. The guidance for adjusting the other reported carbon stocks is shown in Table 6.2.

Table 6.2. Guidance for Adjusting Other Carbon Pools

Carbon Pool	Relationship to Adjustments of Aboveground Live Carbon Stocks	Adjustment
Belowground Standing Live Carbon Stocks	Directly Proportional	$\boldsymbol{SAB_{bg,y}} = \left(\boldsymbol{SAB_{ag,y}} / \boldsymbol{SUB_{ag,y}}\right) \times \boldsymbol{SUB_{bg,y}}$ *Where,* $SAB_{bg,y}$ = *Standardized Adjusted Baseline* for belowground standing live carbon stocks in year *y* $SAB_{ag,y}$ = *Standardized Adjusted Baseline* for aboveground standing live carbon stocks in year *y* $SUB_{ag,y}$ = *Standardized Unadjusted Baseline* for aboveground standing live carbon stocks in year *y* $SUB_{bg,y}$ = *Standardized Unadjusted Baseline* for belowground standing live carbon stocks in year *y*
Aboveground and Belowground Standing Dead Carbon Stocks	N/A	No adjustment is conducted. Aboveground and belowground standing dead carbon stocks remain constant with inventories of aboveground and belowground standing dead carbon stocks at the project start date. Exceptions may be allowed as described previously. Standing dead carbon stocks are not adjusted based on changes to standing live carbon stocks, but must be used in the comparison to Common Practice.

Harvested Aboveground Standing Live Carbon Stocks	Inversely Proportional	$$SAB_{ht,y} = \frac{(SUB_{ht,y}/SUB_{ag,y})}{(SAB_{ag,y}/SUB_{ag,y})}$$ *Where,* $SAB_{ht,y}$ = *Standardized Adjusted Baseline* for harvested aboveground and belowground standing live carbon stocks in year *y* $SUB_{ht,y}$ = *Standardized Unadjusted Baseline* for harvested aboveground and belowground standing live carbon stocks in year *y* $SUB_{ag,y}$ = *Standardized Unadjusted Baseline* for aboveground standing live carbon stocks in year *y* $SAB_{ag,y}$ = *Standardized Adjusted Baseline* for aboveground standing live carbon stocks in year *y*
Harvested Bole Portion of Aboveground Standing Live Carbon Stocks	Inversely Proportional	$$SAB_{htb,y} = \frac{(SUB_{htb,y}/SUB_{ag,y})}{(SAB_{ag,y}/SUB_{ag,y})}$$ *Where,* SAB_{htb} = *Standardized Adjusted Baseline* for the bole portion of harvested aboveground and belowground standing live carbon stocks in year *y* $SUB_{htb,y}$ = *Standardized Unadjusted Baseline* for the bole portion of harvested aboveground and belowground standing live carbon stocks in year *y* $SUB_{ag,y}$ = *Standardized Unadjusted Baseline* for aboveground standing live carbon stocks in year *y* $SAB_{ag,y}$ = *Standardized Adjusted Baseline* for aboveground standing live carbon stocks in year *y*

Step 8 – Combine All Standardized Adjusted Baseline Components

The *Final Baseline* is the sum of *standardized adjusted baselines* for all reported *onsite* carbon stocks and must include:

- Aboveground standing live carbon stocks
- Belowground standing live carbon stocks
- Aboveground and belowground standing dead carbon stocks

The standardized adjusted baselines for harvested standing live carbon stocks (aboveground and belowground) and the bole portion of harvested standing live carbon stocks must be maintained separately from the carbon stocks listed above. The reporting of harvested carbon stocks is conducted separately from other reported carbon stocks.

6.2.2 Estimating Baseline Onsite Carbon Stocks – Public Lands

The baseline is developed for a public forest by determining carbon levels in the Project Area with the assumed condition that the entire forest is at a rotation age common for the forest community (by Assessment Area). The rotation ages are provided as default values and are found with the Assessment Area data. Where forest practice laws, or any other legal encumbrances, require specific management of forest stands at levels that exceed the age criteria mentioned above, the stands must be managed at sufficient stocking levels to ensure compliance with the legal constraints. Project credits are determined by calculating the project's carbon stocks and subtracting the baseline stocks from them.

Using the Carbon Online Estimator (COLE[17]), select Forest Inventory and Analysis (FIA) plots using the "plots within this radius" tool. The circle developed must be centered within the Project Area. The radius of the sample area must be at least 100 kilometers. Following the guidance on the website, fetch the data within the circle. Next, filter the data using the 'Filter' tab on the website by selecting species in the 'Forest Type' menu bar that are found in the species list in the Assessment Area Data File for Assessment Area(s) the project is in. Click on the 'Reports' tab and submit the request to produce the 1605(b) report, which will be provided through a web interface. The report must be included as an appendix in the PDD.

Using Table 1 of the COLE 1605(b) report, the baseline for the project, barring any adjustments as part of the legal analysis (below), shall be determined by summing the live tree and dead tree values from the COLE 1605(b) report that correspond with the rotation length value found in Table 6.3. The 1605(b) values are given as metric tons of carbon per hectare and shall be converted into metric tons CO_2e per acre. The determination of rotation length is made using the Assessment Area Data File and identified for rotation length.

Table 6.3. Table Rotation Lengths

Rotation Length	Years
Short	30
Medium	40
Long	60
Extremely Long	70

6.2.2.1 Adjust for Legal Constraints

The baseline must exceed all legal constraints. A determination must be made whether the legal constraints that affect forest management within the Project Area require further adjustments to the initial baseline developed above, using the following steps:

1. Identify legal constraints affecting the Project Area.
    a. Identify and describe the legal requirements affecting the Project Area.
    b. Spatially identify (map) the areas to which the legal requirements apply within the Project Area to determine the affected acres.
2. Determine forest structure needed to comply with the legal requirements.
    a. Describe the forest structure needed to ensure compliance with the legal requirements affecting each area.
    b. Explain and justify the forest conditions and associated age class that meets the forest conditions identified for meeting the minimum criteria of the legal requirement. In no case shall the age class be less than the age class associated with the rotation length from Table 6.3.
3. Adjust baseline values
    a. Use the live and dead tree values associated with the age class from the COLE 1605(b) report that is associated with the previous step. The 100-year values for

[17] http://www.ncasi2.org/COLE/. After opening, zoom into project area on map and follow instructions to "get plots within this radius…". Once the data has been retrieved, the report can be obtained following the instructions on the site.

live and dead trees in the COLE 1605(b) report shall be used in cases where determinations of forest structure are not easily justified.

b. Develop a weighted average by multiplying the acres for each constraint class by the COLE 1605(b) values and dividing by the total acres to determine the adjusted baseline.

6.2.2.2 Estimate the Project's Harvested Wood Products

The estimate of harvested wood products shall be determined by multiplying the adjusted baseline (above) by 3%.

6.2.2.3 Determining the Final Project Baseline

The final baseline is determined by adding the estimated harvested wood products to the adjusted baseline. This value shall remain constant for the project life.

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* amount of carbon in standing live carbon stocks (prior to delivery to a mill) that would have been harvested in each year of the baseline over 100 years. The result will be a uniform estimate of harvested carbon in each year of the baseline. This estimate is determined at the project outset, using the same biomass equations used to calculate biomass in live trees, and will not change over the course of the project.
    a. For projects on private lands, the amount of harvested carbon 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 amount of harvested carbon must be derived from the growth and harvesting regime assumed in the baseline for onsite carbon stocks derived in Section 6.2.2.
2. On an annual basis, determine the amount of harvested carbon that would have remained stored in wood products, averaged over 100 years, following the requirements in the Quantification Guidance.

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 or a stand table projection to "grow" (project forward) prior-year data from existing forest inventory plots to the current reporting year. Guidance for projecting forest inventory data is identified in the Quantification Guidance.
3. Updating the forest inventory estimate for harvests and/or disturbances that have occurred during the previous year. To allow some flexibility in updating the forest inventory during onsite verification years, a project may defer updating a small percentage of plots until the following reporting period, as detailed in the Quantification

Guidance. This will help streamline the sequential sampling process when recent disturbances have taken place.

4. Applying an appropriate confidence deduction for the inventory based on its statistical uncertainty, following the guidance in the Quantification Guidance.

6.2.5 Determining Actual Carbon in Harvested Wood Products

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

1. Determine the actual amount of carbon in standing live carbon stocks (prior to delivery to a mill) harvested in the current year (based on harvest volumes determined in Section 6.2.4).
2. Determine the amount of actual harvested carbon that will remain stored in wood products, averaged over 100 years, following the requirements in the Quantification Guidance.

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. Changes in energy-related emissions, which could result from a Forest Project causing consumers of forest products to increase or decrease their use of alternative materials, are not accounted for because it is assumed that energy sector emissions are accounted for by energy sector reporting.

The assumption under this protocol is that some Secondary Effects will occur because of project activities. However, the amount of Secondary Effects is dependent on how much harvesting occurs on the Project Area relative to the baseline scenario. Equation 6.10 must be used to estimate Secondary Effects for Improved Forest Management Projects. Per Equation 6.10, up to 80% of the difference between actual and baseline harvested carbon may be applied as Secondary Effects.

Recognizing that Secondary Effects from a project may be influenced by long term harvesting trends, the evaluation in Equation 6.10 considers cumulative harvest amounts since project inception. When less harvesting has occurred on the Project Area since project commencement relative to the amount harvested under the baseline scenario, the Secondary Effects value for the current reporting period may be either negative or positive, depending on how actual and baseline harvest amounts for the current reporting period compare. As a result, net GHG reductions for the reporting period are lowered when actual onsite harvested carbon for the year is less than the baseline amount.

When actual onsite harvested carbon during a reporting period is greater than the baseline amount, net GHG reductions are increased. This allows for deductions for prior negative Secondary Effects to be recouped. However, once actual cumulative harvest amounts exceed baseline cumulative harvest amounts, Secondary Effects are zero – under no circumstances shall the net balance of the Secondary Effects over the course of a project be positive.

Values used for onsite carbon harvested in the project and baseline scenarios ($AC_{hv,n}$ and $BC_{hv,n}$) shall represent all harvested trees, not just merchantable species.

Equation 6.10. Secondary Effects Emissions

If the Forest Project is based on management that includes ongoing timber harvests:

$$\boldsymbol{If}\ \sum_{\boldsymbol{n=1}}^{\boldsymbol{y}}(\boldsymbol{AC_{hv,n}} - \boldsymbol{BC_{hv,n}}) > 0, then\ \boldsymbol{SE_y} = \boldsymbol{0}$$

$$\boldsymbol{If}\ \sum_{\boldsymbol{n=1}}^{\boldsymbol{y}}(\boldsymbol{AC_{hv,n}} - \boldsymbol{BC_{hv,n}}) < 0, then\ \boldsymbol{SE_y} = (\boldsymbol{AC_{hv,y}} - \boldsymbol{BC_{hv,y}})\times\boldsymbol{MIN}\left(\left|\frac{(\boldsymbol{AC_{hv,y}} - \boldsymbol{BC_{hv,y}})}{\boldsymbol{BC_{hv,y}}}\right|, \boldsymbol{0.8}\right)$$

Where,

			Units
SE_y	=	Estimated annual Secondary Effects (used in Equation 6.1)	tCO_2e
$AC_{hv,n}$	=	Actual amount of onsite carbon harvested in reporting period n (prior to delivery to a mill)	tCO_2e
$BC_{hv,n}$	=	Estimated average baseline amount of onsite carbon harvested in reporting period n (prior to delivery to a mill), as determined in Step 1 of Section 6.2.3	tCO_2e
$AC_{hv,y}$	=	Actual amount of onsite carbon harvested in current reporting period *y* (prior to delivery to a mill)	tCO_2e
$BC_{hv,y}$	=	Estimated average baseline amount of onsite carbon harvested in current reporting period *y* (prior to delivery to a mill), as determined in Step 1 of Section 6.2.3	tCO_2e
y	=	Current reporting period (i.e., number of reporting periods completed since project start date)	
n	=	Reporting period (*n* = 1 to *y*)	

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 a baseline
2. Adjusting the baseline based on conversion risk

Step 1 – Characterizing and Projecting the Baseline

Project Operators 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 by this protocol). The appraisal must include accompanying documentation that demonstrates the type of anticipated land use conversion is legally permissible. Such documentation must fall into at least one of the following categories:
    a. 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.

b. Documentation indicating that the Project Operator 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.).
c. 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.).

2. Estimating the rate of conversion and removal of onsite standing live and dead carbon stocks. The rate of conversion and removal of onsite standing live and dead carbon stocks must be estimated by either:
   a. Referencing planning documentation that has been approved and permitted by the appropriate planning department 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
   b. In the absence of specific documentation, identifying a default annual conversion rate for carbon in standing live and dead carbon stocks from Table 6.4. The default value is subject to any legal constraints, which must be incorporated in modeling the project's baseline.

Table 6.4. Default Avoided Conversion Rates for Standing Live and Dead Carbon Stocks

Type of Conversion Identified in Appraisal	Total Conversion Impact	Annual Rate of Conversion
	This is the assumed total effect over time of the conversion activity on standing live and dead carbon stocks. (The total conversion impact is amortized over a 10-year period to determine the annual rate of conversion in the next column.)	This is the assumed annual rate of the conversion activity on standing live and dead carbon stocks. The percentages below are multiplied by the initial standing and dead carbon stocks for the project on an annual basis for the first 10 years of the project.
Residential	Estimate using the following formula: TC% = (min(1,(P*3) / PA)) *Where,* TC = % total conversion (TC cannot exceed 100%) PA = the Project Area (acres) identified in the appraisal P = the number of unique parcels that would be formed on the Project Area as identified in the appraisal * Each parcel is assumed to deforest 3 acres of forest vegetation	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%

A computer simulation, based on 2a or 2b above, must be conducted to project changes in onsite standing live and dead carbon stocks over 100 years. The computer simulation of the onsite standing live and dead carbon stocks must approximate the identified rate of conversion over time to estimate changes in standing live and dead carbon stocks, beginning with the Project Area's initial onsite standing live and dead carbon stocks. If the projected conversion rate does not result in a complete removal of onsite standing live and dead carbon stocks, the baseline projection must account for any residual forest carbon value as a steady condition for the balance of a 100-year projection. See Figure 6.3 for an example of a projected decline in standing live and dead carbon stocks for a hypothetical project that avoids agricultural conversion, using an appropriate conversion rate from Table 6.5.

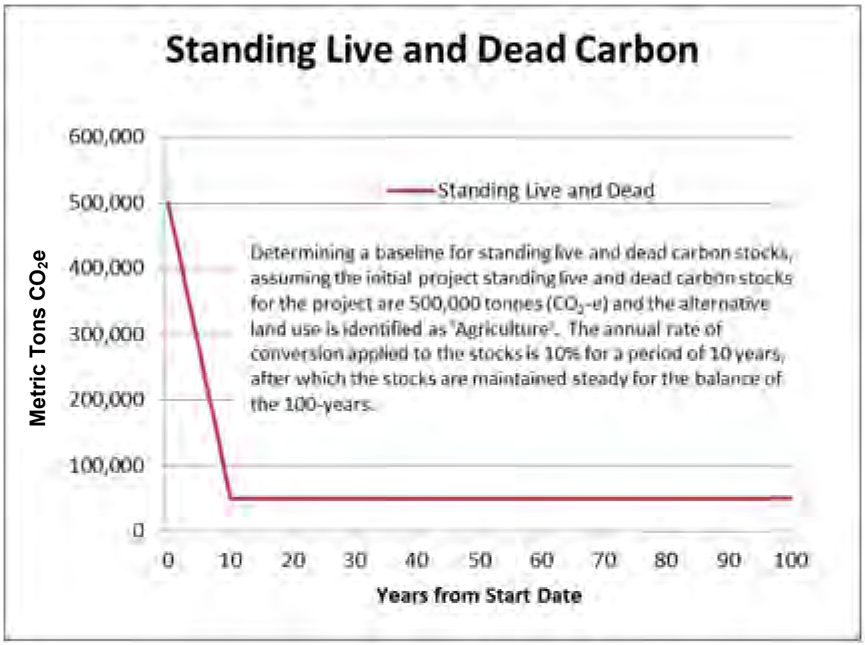


Figure 6.3. Example of an Avoided Conversion Project Baseline for Onsite Standing Live and Dead Carbon Stocks

3. Estimating the rate of soil carbon emissions (optional):
   With the exception of histosols, soil carbon emissions can only be quantified for conversion to agriculture at this time. Soil carbon emissions associated with conversion to residential and commercial are allowed for histosols as well. The amount of soil carbon and the rate of soil carbon emissions are dependent upon the soil type (Order) and the conversion activity. Emissions from soil carbon are estimated by applying the default emissions estimators from Table 6.5 below to the estimates of soil carbon in the Project Area. Table 6.5 provides an estimated percentage emitted as the result of conversion and presents the rate of emissions associated with each soil order.

Table 6.5. Soil Carbon Emissions Estimators by Soil Order

Soil Order		*Alfisol*	*Andisol*	*Inceptisol*	*Mollisol*	*Spodosol*	*Ultisol*	*Histosol*
Estimated Emissions Associated with Conversion Activity	**Agriculture**	30%	30%	30%	30%	30%	30%	80%
	Residential/ Commercial/ Industrial	0%	0%	0%	0%	0%	0%	80%
Rate of Estimated Emissions		100% in first 10 years	100% in first 10 years	100% in first 10 years	100% in first 10 years	100% in first 10 years	100% in first 10 years	10% per 10-year period

A weighted estimate of emissions must be conducted where more than one soil order is found in the Project Area.

Table 6.6. Example of the Computation of Weighted Soil Carbon Estimates

Soil Order and Project Acres	Estimated Soil CO_2e (t) per Acre	Rate of Emissions	Total Emissions	Soil Carbon Inventory and Emissions	Project Start Date	10 Years	20 Years	30 Years	40 Years	50 Years	60 Years	70 Years	80 Years	90 Years	100 Years
Histosols 500	285	8% of original inventory estimate every 10 years	80%	CO_2e Metric Tons Total	142,500	131,000	119,700	108,300	96,900	85,500	74,100	62,700	51,300	39,900	28,500
				Decadal Emissions	11,400	11,400	11,400	11,400	11,400	11,400	11,400	11,400	11,400	11,400	0
Ultisols 500	60	30% of original inventory estimate in first 10 years	30%	CO_2e Metric Tons Total	30,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000
				Decadal Emissions	9,000	0	0	0	0	0	0	0	0	0	0
Totals															
1000	172.5			CO_2e Metric Tons Total	172,500	159,300	147,900	136,500	125,100	113,700	102,300	90,900	79,500	68,100	56,700
				Decadal Emissions	20,400	11,400	11,400	11,400	11,400	11,400	11,400	11,400	11,400	11,400	11,400

The baseline trend of soil carbon stocks must be graphed to display the soil carbon stocks on an annual basis. Annual soil carbon emissions are derived from the decadal soil carbon emissions by dividing by ten. Figure 6.4 displays the baseline trend of soil carbon using the example presented in Table 6.6.

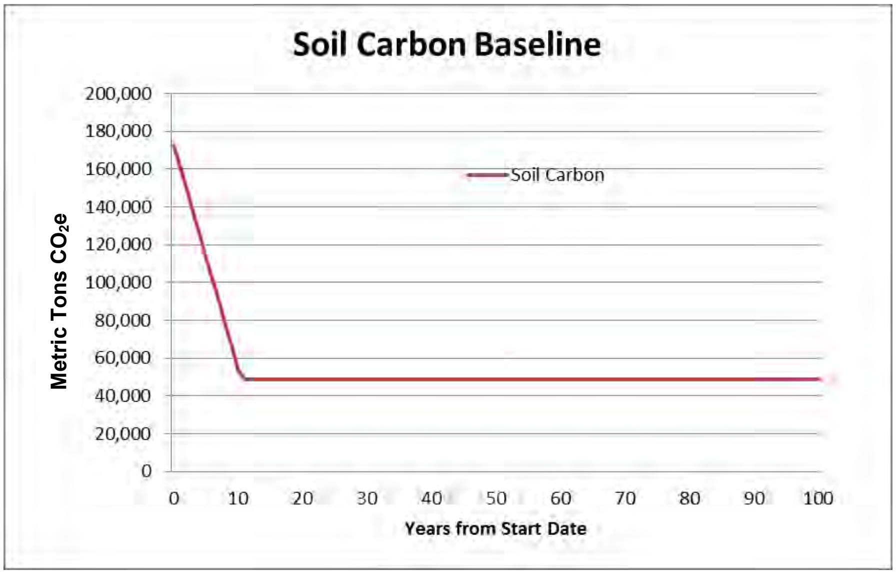


Figure 6.4. Example of an Avoided Conversion Project Baseline for Soil Carbon Stocks

The carbon stock trends for standing live carbon, standing dead carbon, and soil carbon are added together to determine a project baseline for the onsite carbon stocks. Figure 6.5 displays the baseline trend of soil carbon and standing live and dead carbon, using the example data provided above.

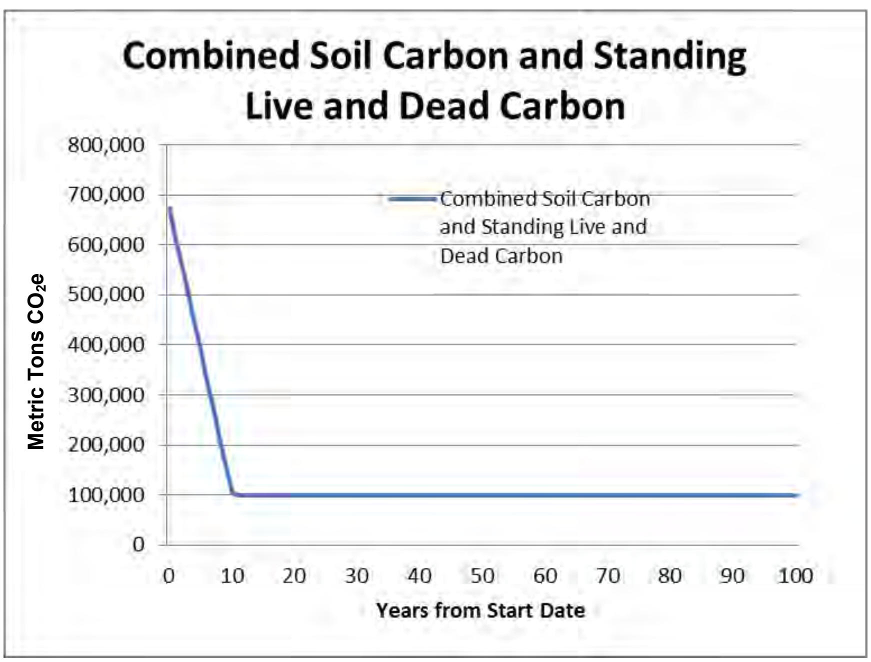


Figure 6.5. Example of an Avoided Conversion Project Baseline for the total Onsite Carbon Stocks

Step 2 – Adjusting the Baseline Based on Conversion Risk

If the fair market value of the anticipated alternative land use for the Project Area (as determined by the required appraisal) is *not more than 80 percent greater* than the value of the current forested land use, then the baseline must be adjusted to reflect uncertainty about the risk of conversion.

Equation 6.11. Conversion Risk Adjustment Factor

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

Where,

CRA	=	Conversion Risk Adjustment factor
VA	=	Appraised fair market value of the anticipated alternative land use for the Project Area
VP	=	Appraised fair market value of the current forested land use for the Project Area

The baseline is adjusted by applying the Conversion Risk Adjustment factor to the unadjusted baseline determined in Step 1, using Equation 6.12 below.

Equation 6.12. Adjusted Baseline Onsite Carbon Stocks

$$BC_{onsite,y} = BLU_y + (IS - BLU_y) \times CRA$$

Where,

			Units
$BC_{onsite,\,y}$	=	Adjusted baseline onsite carbon stocks in year y, for each of the 100 years calculated in the project's baseline	tCO_2e
BLU_y	=	Unadjusted baseline onsite carbon stocks in year y, for each of the 100 years calculated in the project's baseline (determine in Step 1, above)	tCO_2e
IS	=	Initial onsite carbon stocks at the project start date	tCO_2e
CRA	=	Conversion Risk Adjustment factor, as described above	%

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 amount of carbon in standing live carbon stocks (prior to delivery to a mill) that would have been harvested in each year, consistent with the rate of reduction in baseline standing live carbon stocks determined in Section 6.3.1. This projection is determined at the project outset, using the same biomass equations used to calculate biomass in live trees, and will not change over the course of the project.
2. On an annual basis, determine the amount of harvested carbon that would have remained stored in wood products, averaged over 100 years, following the requirements in the Quantification Guidance.

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 the Quantification Guidance. Guidance for projecting forest inventory plot data using models is also provided in the Quantification Guidance.
3. Updating the forest inventory estimate for harvests and/or disturbances that have occurred during the previous year. To allow some flexibility in updating the forest inventory, a project may defer updating a small percentage of plots until the following reporting period, as detailed in the Quantification Guidance.
4. Applying an appropriate confidence deduction for the inventory based on its statistical uncertainty, following the guidance in the Quantification Guidance.

6.3.4 Determining Actual Carbon in Harvested Wood Products

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

1. Determine the actual amount of carbon in standing live carbon stocks (prior to delivery to a mill) harvested in the current year (based on harvest volumes determined in Section 6.3.2).
2. Determine the amount of actual harvested carbon that will remain stored in wood products, averaged over 100 years, following the requirements in the Quantification Guidance.

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, Project Operators must quantify Secondary Effect emissions using Equation 6.13. The value for Secondary Effect emissions will always be negative or zero.

Equation 6.13. Secondary Effects Emissions

$$\boldsymbol{SE_y = (-1) \times 3.6\% \times (\Delta AC_{onsite} - \Delta BC_{onsite})} \text{ or 0, whichever is lower}$$

Where,

			Units
SE_y	=	Secondary Effect GHG emissions caused by the project activity in year y (Equation 6.1)	tCO_2e
ΔAC_{onsite}	=	Annual difference in actual onsite carbon as defined in Equation 6.1	tCO_2e
ΔBC_{onsite}	=	Annual difference in baseline onsite carbon as defined in Equation 6.1	tCO_2e

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 Project Operators to monitor onsite carbon stocks, submit regular monitoring reports, and submit to regular third-party verification of those reports along with periodic verification site visits (as detailed in Sections 7 through 9 of this protocol) for the duration of the Project Life.
2. The requirement for all Project Operators to sign a Project Implementation Agreement with the Reserve, as described in Section 3.6, which obligates Project Operators 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 as 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. Under this protocol, reversals due to controllable agents are considered "avoidable". As described in this section, Project Operators 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 visit 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 quantified GHG reductions and removals (i.e., QR_y in Equation 6.1) in a given year are negative, and CRTs were issued to the Forest Project in any previous year, 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 QR_y.

7.2 Insuring Against Reversals

The Reserve requires Project Operators 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 tons 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 ten CRTs after annual verification, and the project's reversal risk rating is ten percent, then nine CRTs will be issued to the Project Operator's Reserve account and 1 CRT must be deposited in the Buffer Pool.

Project Operators must determine the reversal risk rating for a project by following the requirements and guidance in Appendix A. The risk rating must be determined prior to registration, and recalculated in every year the project undergoes a verification site visit (see Section 9.3.2).

Project Operators who record a Qualified Conservation Easement or Qualified Deed Restriction in conjunction with implementing a Forest Project will receive a lower risk rating (see Appendix A).

Project Operators 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 Project Operator in proportion to the reduced risk. Similarly, however, the Reserve may require additional contributions to the Buffer Pool if the risk rating increases, to ensure that all CRTs (including those issued in prior years) are properly insured.

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 Project Operator's behalf by retiring CRTs from the Buffer Pool. If a reversal was avoidable (as defined below) then the Project Operator 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 Project Operator's negligence, gross negligence or willful intent, including wildfires or disease that are not the result of the Project Operator's negligence, gross negligence or willful intent. Requirements for Unavoidable Reversals are as follows:

1. If the Project Operator 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 Project Operator must explain the nature of the Unavoidable Reversal and provide a verified estimate of onsite carbon stocks so that the reversal can be quantified (in units of CO_2-equivalent metric tons).
    a. Annual monitoring reports submitted for the project must provide observations of ongoing mortality. Based on such observations, an estimate of mortality related to the natural disturbance must be provided. Once mortality has stabilized to background levels, a full verified estimate of the onsite carbon stocks must be submitted to the Reserve, no later than 2 years following the occurrence. Exceptions to this timing may be made if the Reserve agrees that an extension is warranted, for example, if mortality has not stabilized. Observations submitted by the Project Operator are subject to oversight by the Reserve.

If the Reserve determines that there has been an Unavoidable Reversal, it will retire a quantity of CRTs from the Buffer Pool equal to the size of the reversal in CO_2-equivalent metric tons (i.e., QR_y, as specified in Equation 6.1).

7.3.2 Avoidable Reversals

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

1. If an Avoidable Reversal has been identified during annual monitoring, the Project Operator must give written notice to the Reserve within thirty days of identifying the reversal.
2. Alternatively, if the Reserve determines that an Avoidable Reversal has occurred, it shall deliver written notice to the Project Operator. Within thirty days of receiving the avoidable reversal notice from the Reserve, the Project Operator must provide a written description and explanation of the reversal to the Reserve.
3. Within a year of notifying the Reserve of an Avoidable Reversal or receiving the Avoidable Reversal notice, the Project Operator must provide the Reserve with a verified estimate of current onsite carbon stocks.
4. Within four months of the Reserve's approval of the verified estimate of onsite carbon stocks, the Project Operator must retire a quantity of CRTs from its Reserve account equal to the size of the reversal in CO_2-equivalent metric tons (i.e., QR_y, as specified in Equation 6.1). In addition:
    a. The retired CRTs must be those that were issued to the Forest Project, unless those CRTs were previously retired for other purposes. Otherwise, the retired CRTs must be from 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 standing live carbon stocks below its approved baseline standing live carbon stocks, the Forest Project will automatically be terminated, as the original approved baseline for the project would no longer be valid. If the Forest Project is automatically terminated due to an Unavoidable Reversal, another project may be initiated and submitted to the Reserve for registration on the same Project Area. New projects may not be initiated on the same Project Area if the Forest Project is terminated due to an Avoidable Reversal.

If the Forest Project has experienced a reversal and its actual standing live 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

This section provides requirements and guidance on project monitoring, reporting rules and procedures.

8.1 Project Documentation

Project Operators must provide the following documentation to the Reserve in order to register a forest project.

- Project Submittal form
- KML file
- Project Design Document
- Signed Attestation of Title form
- Signed Attestation of Regulatory Compliance form
- Signed Attestation of Voluntary Implementation form
- Verification Report
- Verification Statement
- Project Implementation Agreement

Project Operators must provide the following documentation each time a Forest Project is verified in order for the Reserve to issue CRTs for quantified GHG reductions.

- Monitoring report
- Calculation worksheet
- Verification Report
- Verification Statement
- Signed Attestation of Title form
- Signed Attestation of Regulatory Compliance form
- Signed Attestation of Voluntary Implementation form (Improved Forest Management projects only)
- Project Implementation Agreement Amendment

Project submittal forms can be found at http://www.climateactionreserve.org/how/program/documents/.

All reports that reference carbon stocks must be submitted with the oversight of a Professional Forester, for jurisdictions with a Professional Forester law or regulation, or a Certified Forester, managed by the Society of American Foresters (see www.certifiedforester.org) so that professional standards and project quality are maintained. Any Professional Forester or Certified Forester preparing a project in an unfamiliar jurisdiction must consult with a Professional Forester or Certified Forester practicing forestry in that jurisdiction to understand all laws and regulations that govern forest practice within the jurisdiction. 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.

All projects shall submit a KML file depicting the Project Area that matches the maps submitted to depict the Project Area. The project's reported acres shall be calculated in accordance with the requirements in Section 4.1. The Reserve will create a file of all verified forest carbon projects on Google Maps for public dissemination.

8.1.1 Forest Project Design Document

The forest Project Design Document (PDD) is a required document for reporting information about a project. The document is submitted at the initial verification. A PDD template has been prepared by the Reserve and is available on the Reserve's website. The template is arranged to assist in ensuring that all requirements of the FPP are addressed. The template is required to be used by all projects. The template is designed to manage the varying requirements based on project type.

Each project must submit a PDD at the project's first verification. The Project Operator must include a general description of the methodology that will be incorporated by the Project Operator to update their inventory estimates on an annual basis per guidance in the Quantification Guidance on the FPP webpage for the reported carbon pools.

PDDs are intended to serve as the main project document that thoroughly describes how the project meets eligibility requirements, discusses the quantification methodologies utilized to generate project estimates, outlines how the project complies with terms for additionality and describes methods for updating inventory estimates and how permanence will be addressed, including how project reversal risks are calculated. All methodologies used by Project Operators and descriptions in the PDD must be clear in a way that facilitates review by verifiers, Reserve staff, and the public. PDDs must be of professional quality and free of incorrect citations, missing pages, incorrect project references, etc.

8.2 Monitoring Report

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. Project Operators must conduct monitoring activities and submit monitoring reports according to the schedule and requirements presented in Section 8.3. 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, entering the updated inventory into the Forest Project's Calculation Worksheet, and submitting it to the Reserve at frequencies defined in Section 8.3. CRTs are only issued in years that the project data are verified, as described in Section 9.

A monitoring report must be prepared for each Reporting Period. Monitoring reports must be provided to verification bodies whenever a Forest Project undergoes verification. In addition, monitoring reports must be provided to the Reserve upon the completion of any Reporting Period for which verification will be deferred (e.g., if the Project Operator foregoes a desk-review verification). All monitoring reports are due within 12 months of the end of the Reporting Period. Monitoring reports must include an update of the project's calculation worksheet. The project's calculation worksheet includes:[18]

[18] Reforestation Projects, as described in Section 6.1, can defer the items that are marked with an asterisk until the second site visit verification.

1. An updated estimate of the current year's carbon stocks in the reported carbon pools. 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 the Reserve. Any changes in inventory estimates associated with the use of the modified inventory methodology will need to be reconciled with previously verified project inventory estimates and baseline projections. The updated estimate of carbon stocks is determined by:
    a. Including any new forest inventory data obtained during the Reporting Period.
    b. *Applying growth estimates to existing inventory.
    c. Updating inventory estimates for harvest and/or disturbances that have occurred during the Reporting Period.
2. *The appropriate confidence deduction for the forest carbon inventory, as determined at the last full site visit verification for the project (following the Quantification Guidance). The same confidence deduction must be used in interim years between verification site visits.
3. *An estimate of current-year harvest volumes and associated carbon in harvested wood products.
4. *Estimated mill efficiency, as determined following the Quantification Guidance.
5. *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.
6. 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.
7. 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.)
8. *A preliminary calculation of total net GHG reductions and removals (or reversals) for the year, following the requirements in Section 6.
9. *The project's reversal risk rating, as determined following the requirements in Section 7 and Appendix A. The risk rating is updated during each full site visit verification. Between verification site visits, the project's reversal risk rating does not change.
10. *A preliminary calculation of the project's Buffer Pool contribution.

In addition to data reported using the project calculation worksheet, the following must be submitted to the Reserve as part of a monitoring report.

For each Reporting Period:

1. 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.

Conditional reporting, as pertinent:

1. *An explanation for any decrease over any ten-year consecutive period in the standing live carbon pool.

2. Any changes in the status of the Project Operator including, if applicable per Section 3.9.1, the acquisition of new forest landholdings.
3. If a reversal has occurred during the previous year, the report must provide a written description and explanation of the reversal, whether the Reserve classified the reversal as Avoidable or Unavoidable, and the status of compensation for the reversal.

8.3 Reporting and Verification Cycle

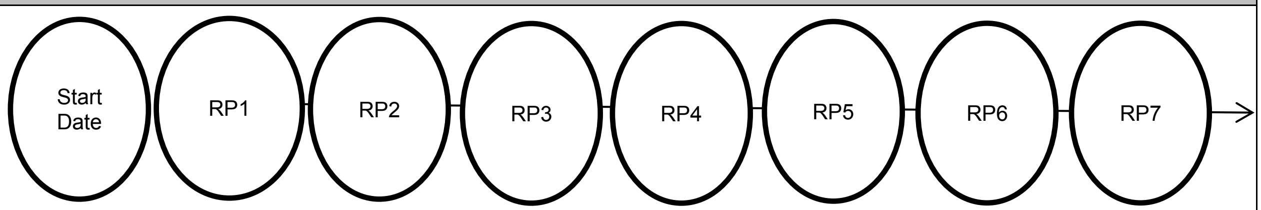
A Forest Project is considered automatically terminated (see Section 3.5) if the Project Operator chooses not to report data and undergo verification at required intervals.

8.3.1 Reporting Period Duration and Cycle

A Reporting Period is a discrete period of time for which a Project Operator quantifies and reports GHG reductions and removals, as well as required project data to the Reserve. The initial Reporting Period may cover any length of time, up to one year. Reporting Periods subsequent to the initial Reporting Period must cover 12 months of project activity. Harvested Wood Products should not be reported as of the project start date. Figure 8.1 displays the Reporting Periods in graphical form.

Reporting Periods must be contiguous, i.e., there must be no gaps in reporting during the crediting period of a Forest Project once the first reporting period has commenced.

Forest Reporting Period Schedule



Reporting Period	Project Start Date	1	2	3	4	5	6	7
Time from last report date	N/A	As desired to establish a reporting cycle (up to 1 year in length)	1 year	1 year	1 year	1 year	1 year	1 year
Site Visit Verification Required?	N/A	Yes	No[19]	No	No	No	No	Yes

Figure 8.1. Forest Project Reporting Schedule

8.3.2 Verification Cycle

All Forest Projects must be initially verified within 30 months of being submitted to the Reserve. The initial verification of all project types must include a site visit, confirm the project's eligibility, and confirm that the project's initial inventory and the baseline have been established in conformance with the FPP. Subsequent verification may include multiple Reporting Periods and is referred to as the "Verification Period." The end date of any Verification Period must correspond to the end date of a Reporting Period.

[19] A site visit verification may be required earlier, if the Project Operator chooses to establish a new confidence deduction or reversal risk rating.

Verification is required at specific intervals to ensure that ongoing monitoring of forest carbon stocks, inventory confidence, and risk ratings are accurate and up to date. Optional verification is at the Project Operator's discretion and may be conducted between required verifications for crediting (non-aggregated projects), to adjust the project's confidence estimate and/or risk ratings, among other rationale, based on changed management circumstances. The schedule of required verification is dependent upon the project type and whether the project is aggregated or non-aggregated. Details of verification scheduling requirements are provided in Sections 8.3.2.1 and 8.3.2.2.

Verification must be completed within 12 months of the end of the Reporting Period(s) being verified. For required verifications, failure to complete verification within the 12 month time period will result in account activities being suspended until the verification is complete. The project will terminate if the required verification is not completed within 36 months of the end of the Reporting Period(s) being verified. There is no consequence for failure to complete verification activities within 12 months for optional verifications.

8.3.2.1 Minimum Required Site Visit Verification Schedule

Non-Aggregated Projects

Except as allowed for the second verification of Reforestation Projects, the Reserve requires that an approved third-party verification body verify all reported data and information for a Forest Project and conduct a site visit for the Verification Period that follows the end of every sixth reporting period following the initial Reporting Period. Site visit verifications are also required any time the Project Operator would like to establish new confidence deductions and/or reversal risk ratings. See Figure 8.1 above for an example of the verification schedule.

For Reforestation Projects, the second verification may be deferred indefinitely beyond end of the sixth reporting period at the discretion of the Project Operator. If deferred, the second verification must be a site visit verification.

Aggregated Projects

Site visit verifications must be conducted on a schedule such that at all times a minimum of 50 percent of the projects in the aggregate (rounding up in the case of an uneven number of projects) have successfully completed a site visit verification within the 12-month time allowance for the previous six years of reporting periods, and that 100 percent of the projects have successfully completed a site visit verification within the 12-month time allowed for the previous 12 years of Reporting Periods. These verification requirements are mandatory regardless of the mix of entry dates represented by the group of projects in the aggregate. The initial site visit verification required for entry into the aggregate may count to meet these site verification obligations.

A site visit verification is required to make an adjustment to the sampling error for a project. However, the confidence deduction may change without a site visit verification for the project if a new project is added to an aggregate, as this will result in a change to the target sampling error for all projects in the aggregate.

On six-year intervals, beginning with the first year of the existence of the aggregate, the verification body must select from the total group of projects those projects that will have scheduled site visit verifications in order to meet these obligations. The process should utilize random selection to the degree possible and still meet the six- and 12-year completion requirements. For example, in the case where there are ten projects that joined the aggregate in the first year, five of those projects should be chosen randomly and complete a site visit verification within 12 months following the sixth reporting period. The site visit verifications may be spread out through each six-year interval or scheduled in a more concentrated manner that economizes on verification expenses. Project Operators may be notified of a site visit verification prior to the year in which the verification is to take place.

The only exception is when a second site visit verification for a Reforestation Project is deferred for more than six reporting periods (see Section 6.1.1). In this case, the calculation of the percentages for meeting the six-year and 12-year minimums may be made by excluding the deferred Reforestation Projects from the totals. After the second site visit verification for a Reforestation Project, this exception is no longer allowed.

8.3.2.2 Desk Review Verification

Non-Aggregated Projects

In between site visit verifications, the Project Operator may choose to have an approved third-party verification body conduct a desk review of annual monitoring reports as an optional verification. CRTs may be issued for GHG reductions/removals verified through such desk reviews. Adjustments may not be made to inventory confidence deductions and/or risk ratings as part of the optional verification. Submission of annual monitoring reports to the Reserve is required even if the Project Operator chooses to forego desk review verification.

Desk review verifications are not permitted for Reforestation Projects between the initial and second site visit verifications if the Project Operator has opted to defer the second verification.

Aggregated Projects

Between site visit verifications, each Project Operator must submit annual project monitoring reports. Verification bodies must annually audit a sample of the annual monitoring reports, equivalent to the square root of the total number of participating projects in the aggregate, or the total number of participating projects divided by 12, whichever is higher (when rounded to the next highest whole number). As an example, an aggregate with 16 projects must have four project monitoring reports verified in a given year. Audited projects must be selected randomly, and must not include projects undergoing site visit verification for the year. Project Operators will not know when their annual monitoring reports will require verification. Since this is a random process, a Project Operator may have the annual report verified in consecutive years or when the project is verified with a required site visit.

Successful verification of a representative sample results in the crediting of all projects participating in the entire aggregate. If verification for a participating project is unsuccessful, the verification body must verify additional participating projects until the total number of successful verifications reaches the required number (as described above). If the required number of successful verifications has not been achieved within 12 months after the date the verification body submits a negative Verification Statement and Report to the Reserve for a project in the aggregate, crediting of all the participant projects in the aggregate will be suspended until the required number of successful verifications has been achieved. If material issues arise during verification of a participant project, the Project Operator will need to independently address the issues and required corrective actions using the same process taken with standalone projects.

The Reserve will not issue CRTs for a project in an aggregate that has an unsuccessful verification. As with other projects, if the project is not successfully verified within 12 months, the project account is suspended. If a participating project is not successfully verified within 36 months of a negative Verification Statement, the project will be automatically terminated.

Aggregators may assist the Project Operator in preparing documents for verification and facilitate the verification process. The scope of these services is determined by the specific contract between the Project Operator and the Aggregator. The ultimate responsibility for monitoring reports and verification compliance is assigned to each participating Project Operator.

Desk review verifications are not permitted for Reforestation Projects between the initial and second site visit verifications if the Project Operator has opted to defer the second verification.

8.3.3 Issuance and Vintage of CRTs

The Reserve will issue Climate Reserve Tonnes (CRTs) for quantified GHG reductions and removals that have been verified through either site visits, desk reviews, or in an aggregate through the aggregated method of site visits and desk reviews described above. A site visit verification may determine that earlier desk reviews overestimated onsite carbon stocks. A net downward adjustment to carbon stock estimates will be treated as a reversal (see Section 7.1). In this case, the Project Operator must retire CRTs in accordance with the requirements for compensating for a reversal (Section 7.3).

Reforestation Projects for which an initial inventory is deferred are not eligible to receive CRTs until after the second site visit verification.

Vintages are assigned to CRTs based on the proportion of days in each calendar year within a reporting period.

8.4 Record Keeping

For purposes of independent verification and historical documentation, Project Operators are required to keep all documents and forms related to the project for a minimum of 100 years after the final issuance of CRTs from the Reserve. This information may be requested by the verification body or the Reserve at any time.

8.5 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.

9 Verification Guidance

This section provides guidance to Reserve-approved verification bodies for verifying GHG emission reductions associated with a planned set of activities to remove, reduce or prevent CO_2 emissions in the atmosphere by conserving and/or increasing forest carbon stocks.

This section supplements the Reserve's Verification Program Manual,[20] which provides verification bodies with the general requirements for a standardized approach for independent and rigorous verification of GHG emission reductions and removals. The Verification Program Manual outlines the verification process, requirements for conducting verification, conflict of interest and confidentiality provisions, core verification activities, content of the verification report, and dispute resolution processes. In addition, the Verification Program Manual explains the basic verification principles of ISO 14064-3:2006 which must be adhered to by the verification body.

Forest Project verification bodies must read and be familiar with the following International Organization for Standardization (ISO) and Reserve documents and reporting tools:

1. Forest Project Protocol (this document)
2. Reserve Program Manual
3. Reserve Verification Program Manual
4. Reserve software
5. ISO 14064-3:2006 Principles and Requirements for Verifying GHG Inventories and Projects

Only Reserve-approved Forest Project verification bodies are eligible to verify Forest Project reports. To become a recognized Forest Project verifier, verification bodies must become accredited under ISO 14065. Information on the accreditation process can be found on the Reserve website at http://www.climateactionreserve.org/how/verification/how-to-become-a-verifier/.

The verification of reports that reference carbon stocks must be conducted with the oversight of a Professional Forester, for jurisdictions with a Professional Forester law or regulation, or a Certified Forester,[21] managed by the Society of American Foresters, so that professional standards and project quality are maintained. Any Professional Forester or Certified Forester verifying a project in an unfamiliar jurisdiction must consult with a Professional Forester or Certified Forester practicing forestry in that jurisdiction to understand all laws and regulations that govern forest practice within the jurisdiction. The Reserve may evaluate and approve alternative certification credentials if requested, but only for jurisdictions where professional forester laws or regulations do not exist.

9.1 Standard of Verification

The Reserve's standard of verification for Forest Projects is the Forest Project Protocol (FPP), the Reserve Program Manual, and the Reserve Verification Program Manual. To verify a land owner's initial Forest Project Design Document and annual monitoring reports, verification

[20] Found on the Reserve website at http://www.climateactionreserve.org/how/program/program-manual/.
[21] See www.certifiedforester.org.

bodies apply the verification guidance in the Reserve's Verification Program Manual and this section of the FPP to the requirements and guidance described in Sections 2 through 8 of the FPP.

This section of the protocol provides requirements and guidance for the verification of projects associated with the three Forest Project types defined in Section 2, i.e., Reforestation Projects, Improved Forest Management Projects, and Avoided Conversion Projects. All three project types involve planned activities that result in conserving and/or increasing forest carbon stocks. This section describes the core verification activities and criteria for each of the three Forest Project types that are necessary for a verification body to provide a reasonable level of assurance that the GHG removals or reductions quantified and reported by Project Operators are materially correct.

Verification bodies will use the criteria in this section to determine if there exists reasonable assurance that the data submitted on behalf of the Project Operator to the Reserve addresses each requirement in the FPP, Sections 2 through 8. Project reporting is deemed accurate and correct if the Project Operator is in compliance with the Section 2 through 8.

Further information about the Reserve's principles of verification, levels of assurance, and materiality thresholds can be found in the Reserve's Verification Program Manual at http://www.climateactionreserve.org/how/program/program-manual/.

9.2 Emission Sources, Sinks, and Reservoirs

For all verification activities, verification bodies review a project's reported sources, sinks, and reservoirs to ensure that all are identified properly and to confirm their completeness. Table 5.1, Table 5.2, and Table 5.3 in Section 5 provide comprehensive lists of all GHG sources, sinks, and reservoirs that must be included in the quantification and reporting of GHG reductions and removals for the three Forest Project types.

It is the Project Operator's responsibility to ensure that verifications are conducted according to the minimum required schedule specified in Section 8.3.2. A Verification Report, List of Findings, and Verification Statement must be submitted within twelve months of the end of any verification period. Site visit verification requirements are described in Section 9.3.2. Desk review verification requirements are described in Section 9.3.3.

9.3 Project Verification Activities

Required verification activities for Forest Projects will depend on whether the verification body is conducting an initial verification for registration on the Reserve, a minimum required verification involving a site visit, or an optional annual verification involving a desk review. Both the initial verification and ongoing verifications must include review of the criteria for Natural Forest Management, inventory of onsite carbon stocks, assessment of carbon in harvested wood products, and review of reversal risk ratings. The following sections contain guidance for all of these verification activities.

9.3.1 Initial Verification

Initial verification includes verification that the Forest Project has met the FPP criteria and requirements for eligibility, Project Area definition, modeling baseline onsite carbon stocks, and calculating baseline carbon in harvested wood products. The initial verification must include a site visit. The verification body must assess and ensure the completeness and accuracy of all required reporting elements for the Forest Project Design Document (Section 8.1.1). Initial verification items are presented in Table 9.1A through 9.1K.

At a Forest Project's initial verification, these items must be verified in addition to all the items required for a standard site visit verification, as detailed in Section 9.3.2.

9.3.1.1 Initial Eligibility

Verification bodies are required to affirm the project's eligibility according to the rules in this protocol. Tables 9.1A, 9.1B, and 9.1C provide the initial verification items concerning eligibility for the three different Forest Project types and include references to sections of this protocol where requirements are further specified.

Table 9.1A. Initial Eligibility Verification Items – Reforestation Projects

Verification Items		Supporting Documentation /Review Process	Section of FPP	Apply Professional Judgment?
1. Project Definition	a. Evidence exists of canopy cover < 10% for 10 years, or b. Evidence of significant disturbance provided. c. Project has demonstrated no consideration of commercial activities. d. No evidence exists for use of broadcast fertilization.	Addressed in PDD	2.1.1	Yes
2. Legal Requirement Test	Proof that a signed Attestation of Voluntary Implementation form is on file with the Reserve.	Consultation with Reserve	3.3.1.1	No
3. Performance Test	a. Reforestation Project that meets 1.a, or b. Meets 1.b and shows that the Forest Project corresponds to an "eligible" scenario in Appendix B, or c. Shows that the project occurs on a type of land for which the Project Operator has not historically engaged in or allowed timber harvesting.	Addressed in PDD	3.3.2.1, Appendix B	Yes (for 3.c)
4. Start Date	Identification of the date on which tree planting occurred or will occur, site preparation for the planting of trees occurred or will occur, or removal of impediments to natural regeneration occurred or will occur (whichever was or will occur first).	Addressed in PDD	3.2	No
5. Project Implementation Agreement	Proof that a Project Implementation Agreement (PIA) between the Project Operator and the Reserve has been signed and recorded in the county of interest.	Consultation with Reserve	3.6	No

6. Project Location	a. Project is in the United States of America or one of the Territories (Reforestation and Avoided Conversion only). b. Project is on private land, or c. If non-federal public lands, provide documentation showing approval by the government agency or agencies responsible, or d. If tribal land, provide documentation that demonstrates that the land within the Project Area is owned by a tribe or private entities.	Address in PDD	3.1	No

Table 9.1B. Initial Eligibility Verification Items – Improved Forest Management Projects

Verification Items		Section of FPP	Apply Professional Judgment?
1. Project Definition	a. Evidence is provided indicating the canopy cover exceeds 10%. b. No evidence exists for use of broadcast fertilization.	2.1.2	Yes (for 1.b)
2. Legal Requirement Test	Proof that a signed Attestation of Voluntary Implementation form is on file with the Reserve.	3.3.1.2	No
3. Start Date	Identification of a discrete, verifiable action that delineates a change in practice relative to the project's baseline.	3.2	No
4. Project Implementation Agreement	Proof that a Project Implementation Agreement (PIA) between the Project Operator and the Reserve has been signed and recorded in the county of interest.	3.6	No
5. Project Location	a. Project is located in the United States of America. b. Project is on private land, or c. If non-federal public lands, provide documentation showing approval by the government agency or agencies responsible, or d. If tribal land, provide documentation that demonstrates that the land within the Project Area is owned by a tribe or private entities.	3.1	No

Table 9.1C. Initial Eligibility Verification Items – Avoided Conversion Projects

Verification Items		Section of FPP	Apply Professional Judgment?
1. Project Definition	a. Proof that the project is/was on private land prior to project initiation. b. Proof that a conservation easement was recorded, or the land was transferred to public ownership. c. Demonstration that conversion out of forest is a significant risk (following the requirements of Section 6.3.1 – see also Table 9.1H). d. No evidence exists for use of broadcast fertilization.	2.1.3, 6.3.1	Yes (for 1.c and 1.d)
2. Legal Requirement Test	a. Proof that a signed Attestation of Voluntary Implementation form is on file with the Reserve. b. Documentation has been provided that demonstrates that the type of land use conversion anticipated by the project is legally permissible; documentation must fall into at least one of the three categories specified in Section 3.3.1.3.	3.3.1.3	No
3. Performance Test	Copy of real estate appraisal for the Project Area indicating conformance to criteria in Section 3.3.2.3.	3.3.2.3	No
4. Start Date	Identification of date on which a conservation easement that dedicates the Project Area to continuous forest cover was recorded or the Project Area was transferred to public ownership.	3.2, 3.7	No
5. Project Implementation Agreement	Proof that a Project Implementation Agreement (PIA) between the Project Operator and the Reserve has been signed and recorded in the county of interest.	3.6	No
6. Project Location	a. Project is located in the United States of America. b. Project is on private land, or c. If non-federal public lands, provide documentation showing approval by the government agency or agencies responsible, or d. If tribal land, provide documentation that demonstrates that the land within the Project Area is owned by a tribe or private entities.	3.1	No

9.3.1.2 Project Area Definition

Verification bodies are required to review the geographic boundaries defining the Project Area and their compliance with the requirements outlined in Section 4 of this protocol. These items are verified only at the project's initiation.

Table 9.1D. Project Area Definition Verification Items

Project Type	Verification Items	Section of FPP	Apply Professional Judgment?
1. All	Proof that a description, shapefile, and maps of the geographic boundaries defining the Project Area are on file at the Reserve. For Reforestation projects, the initial Project Area may be provisional until the second site visit verification in cases where the inventory has been deferred.	4, 8.1	No
2. Avoided Conversion	Project Area has been defined following the guidance in Section 4, Table 4.1 for the appropriate conversion type.	4	No

9.3.1.3 Modeling Baseline Onsite Carbon Stocks

Verification bodies are required to confirm that the Project Operator has developed a baseline characterization for onsite carbon stocks according to the requirements in this protocol. These items are verified only at the project's initiation.

Table 9.1E. Baseline Modeling Verification Items – Reforestation Projects

Verification Items		Section of FPP	Apply Professional Judgment?
1. Qualitative Characterization	Clear qualitative characterization of vegetative conditions and activities that would have occurred without the project.	6.1.1	Yes
2. Inventory of Onsite Carbon Stocks	a. An inventory of the Project Area's carbon stocks in required and optional pools has been conducted in accordance with the requirements and the Quantification Guidance (see Section 9.3.5 for further verification guidance). b. The inventory of carbon stocks has been deferred until the second site visit verification.	6.1.1, Quantification Guidance	Yes
3. Baseline Carbon Stock Modeling	a. A computer simulation has been conducted that models the carbon stocks in accordance with the requirements and guidance in Section 6.1.1 and the Quantification Guidance (see Section 9.3.7 for further verification guidance), or b. The computer simulation has been deferred until the project's second site visit verification.	6, 6.1.1, Quantification Guidance	Yes
4. Description of Forest Project Activities	A description has been provided of the management activities that will lead to increased carbon stocks in the Project Area compared to the baseline.	2	No

Table 9.1F. Baseline Modeling Verification Items – Improved Forest Management Projects – Private Lands

Verification Items		Section of FPP	Apply Professional Judgment?
1. Inventory of Onsite Carbon Stocks	An inventory of the Project Area's carbon stocks in required and optional pools has been conducted in accordance with the requirements and the Quantification Guidance (see Section 9.3.5 for further verification guidance).	6.2.1, Quantification Guidance	Yes
2. Compare Initial Aboveground Standing Live Carbon Stocks with the Minimum Baseline Level	a. The baseline analysis utilizes the correct value for Common Practice and the Minimum Baseline Level (for aboveground standing live carbon stocks) associated with the Assessment Area(s) covered the Project Area. b. Initial aboveground standing live carbon stocks have been estimated correctly following the requirements and the Quantification Guidance.	6.2.1, Determining Common Practice on the Assessment Area Data webpage, Quantification Guidance	No
3. Baseline Carbon Stock Modeling	A 100-year forest management simulation of standing live carbon stocks has been conducted in accordance with the requirements and guidance in Section 6.2.1 and the Quantification Guidance (see Section 9.3.7 for further verification guidance).	6.2.1, Quantification Guidance	Yes
4. Description of Forest Project Activities	A description has been provided of the management activities that will lead to increased carbon stocks in the Project Area compared to the baseline.	2	No

Table 9.1G. Baseline Modeling Verification Items – Improved Forest Management Projects – Public Lands

Verification Items		Section of FPP	Apply Professional Judgment?
1. Initial Forest Carbon Stock Inventory	An inventory of the Project Area's carbon stocks in required and optional pools has been conducted in accordance with the requirements and the Quantification Guidance (see Section 9.3.5 for further verification guidance).	6.2.2, Quantification Guidance	Yes
2. Baseline Carbon Stock Modeling	A 100-year forest management simulation of standing live carbon stocks has been conducted per the requirements in Section 6.2.2 and the Quantification Guidance (see Section 9.3.7 for further verification guidance).	6.2.2, Quantification Guidance	Yes
3. Description of Forest Project Activities	A description has been provided of the management activities that will lead to increased carbon stocks in the Project Area compared to the baseline.	2	No

Table 9.1H. Baseline Modeling Verification Items – Avoided Conversion Projects

Verification Items		Section of FPP	Apply Professional Judgment?
1. Initial Forest Carbon Stock Inventory	An inventory of the Project Area's carbon stocks in required and optional pools has been conducted in accordance with the requirements and the Quantification Guidance (see Section 9.3.5 for further verification guidance).	6.3.1, Quantification Guidance	Yes
2. Baseline Carbon Stock Modeling	a. An alternative highest-value land use for the Project Area has been clearly identified by the required appraisal. b. The rate of conversion and removal of onsite forest carbon stocks has been appropriately estimated in accordance with the requirements of Section 6.3.1, Step 1. c. A 100-year forest management simulation of standing live carbon stocks has been conducted per the requirements in Section 6.3.1, Step 1, and the Quantification Guidance (see Section 9.3.7 for further verification guidance).	3.3.2.3, 6.3.1	Yes
3. Discount for the Uncertainty of Conversion Probability	The Avoided Conversion Discount factor has been correctly calculated per Equation 6.6 in Section 6.3.1, Step 2.	3.3.2.3, 6.3.1	No
4. Description of Forest Project Activities	A description has been provided of the management activities that will lead to increased carbon stocks in the Project Area compared to the baseline.	2	No

9.3.1.4 Calculating Baseline Carbon in Harvested Wood Products

Verification bodies are required to confirm that the Project Operator has developed a baseline characterization for carbon in harvested wood products according to the requirements of this protocol and requirements and guidance in Section 6.2.1, Section 6.2.2, or Section 6.3.2, and the Quantification Guidance.

Table 9.1I. Baseline Carbon in Wood Products Verification Items – Reforestation Projects

Verification Items		Section of FPP	Apply Professional Judgment?
1. Baseline Harvest Volume	If harvesting of any pre-existing trees would be expected to occur in the baseline, the *average* volume of harvesting in each year of the baseline over 100 years has been determined per the requirements and guidance in Section 6.1.2, the Quantification Guidance (see Section 9.3.8 for further verification guidance).	6.1.2, Quantification Guidance	No
2. Long-Term Storage in Wood Products	The average amount of carbon expected to be transferred to wood products each year and stored over the long-term (100 years) has been calculated following the requirements and	6.1.2, Quantification Guidance	No

	guidance of Section 6.1.2 and the Quantification Guidance (see Section 9.3.8 for further verification guidance).		

Table 9.1J. Baseline Carbon in Wood Products Verification Items – Improved Forest Management Projects

Verification Items		Section of FPP	Apply Professional Judgment?
1. Baseline Harvest Volume	The *average* volume of harvesting in each year of the baseline over 100 years has been derived from the growth and harvesting regime used to develop the baseline for onsite carbon stocks, following the requirements and guidance in Section 6.2.1 or 6.2.2, Section 6.2.3, the Quantification Guidance (see Section 9.3.8 for further verification guidance).	6.2.1, 6.2.2, 6.2.3, Quantification Guidance	No
2. Long-Term Storage in Wood Products	The average amount of carbon expected to be transferred to wood products each year and stored over the long-term (100 years) has been calculated following the requirements and guidance of Section 6.2.3 and the Quantification Guidance (see Section 9.3.8 for further verification guidance).	6.2.3, Quantification Guidance	No

Table 9.1K. Baseline Carbon in Wood Products Verification Items – Avoided Conversion Projects

Verification Items		Section of FPP	Apply Professional Judgment?
1. Baseline Harvest Volume	The volume of harvesting in each year of the baseline over 100 years has been derived from the harvesting regime assumed for the baseline for onsite carbon stocks, following the requirements and guidance in Section 6.3.2, the Quantification Guidance (see Section 9.3.8 for further verification guidance).	6.3.2, Quantification Guidance	No
2. Long-Term Storage in Wood Products	The amount of harvested wood that would be delivered to mills in each year has been determined, and the amount of carbon expected to be transferred to wood products each year and stored over the long-term (100 years) has been calculated following the requirements and guidance of Section 6.3.2 and the Quantification Guidance (see Section 9.3.8 for further verification guidance).	6.3.2, Quantification Guidance	No

9.3.2 Site Visit Verification

Site visit verification involves review of the Forest Project's carbon stock inventory estimates, relevant attestations, soil carbon emissions associated with management activities, risk of reversal ratings, and compliance with Natural Forest Management criteria. After a Forest Project's initial verification, subsequent site visits must assess and ensure accuracy in measurement and monitoring techniques and onsite record keeping practices.

Table 9.2. Site Visit Verification Items

Verification Items		Section of FPP	Apply Professional Judgment?
1. Attestation of Title	Proof that a signed Attestation of Title is on file at the Reserve for the dates of the verification period. In addition to reviewing this form, the verification body must conduct a review to confirm ownership and claims to GHG reductions/removals that have occurred over the verification period.	3.7	Yes
2. Attestation of Regulatory Compliance	Proof that a signed Attestation of Regulatory Compliance form is on file with the Reserve for the reporting period. In addition to reviewing this form, the verification body must perform a risk-based assessment to confirm the statements made by the Project Operator in the Attestation of Regulatory Compliance form.	3.8	Yes
3. Attestation of Voluntary Implementation	Proof that a signed Attestation of Voluntary Implementation form is on file with the Reserve for the reporting period. Required for every reporting period for Improved Forest Management projects, and for initial reporting periods only for Reforestation and Avoided Conversion projects.	3.3	No
4. Sustainable Harvesting Practices	a. Commercial harvesting has not commenced within the Project Area, or b. At the time commercial harvesting is initiated within the Project Area, the Project Operator meets sustainable harvest practices on all of its landholdings, as described in Section 3.9.1.	3.9.1	No
5. Change in Project Operator Landholdings	If the Project Operator has acquired additional forestlands outside of the Project Area, the Project Operator must incorporate the newly acquired land in their demonstration of sustainable long-term harvesting practices within 5 years of the acquisition.	3.9.1	No
6. Maintenance of Standing Live Carbon Pool	No decrease has occurred in the Project Area's standing live carbon stocks over any ten-year consecutive period not accounted for by allowable exceptions.	3.9.3	No
7. Natural Forest Management	Natural Forest Management eligibility criteria in Section 3.9.2 have been and continue to be met (see Section 9.3.4 for further verification guidance).	3.9.2	Yes
8. Estimates of Actual Onsite Carbon Stocks	a. An inventory of the Project Area's carbon stocks in required and optional pools has been conducted in accordance with the requirements in Section 6 and the requirements and guidance in the Quantification Guidance (see Section 9.3.5 for further verification guidance), or b. Inventory has been deferred until the second site visit verification for Reforestation Projects.	6.1.3, 6.2.4, 6.3.3, Quantification Guidance	Yes

Verification Items		Section of FPP	Apply Professional Judgment?
9. Estimates of Actual Carbon in Harvested Wood Products	The amount of harvested wood that has been delivered to mills over the reporting period has been determined correctly, and the amount of carbon expected to be transferred to wood products and stored over the long-term (100 years) has been calculated correctly, per the requirements in Section 6 and the requirements and the Quantification Guidance (see Section 9.3.8 for further verification guidance).	6.1.4, 6.2.5, 6.3.4, Quantification Guidance	No
10. Quantification of Primary Effect	Calculations for the Primary Effect are complete and accurate for both onsite carbon stocks and harvested wood products.	6	No
11. Quantification of Secondary Effects	Calculations for quantifying Secondary Effects are complete and accurate.	6.1.5, 6.2.6, 6.3.5	No
12. Reversal Determination	If a reversal has occurred, the type of reversal (avoidable or unavoidable) has been properly identified.	7.3	Yes
13. Reversal Risk Rating	Project's risk rating has been calculated following the requirements of Appendix A	Appendix A	No

9.3.3 Desk Review Verification

For reporting periods in between required site visits, project verification activities may consist of a desk review. During a desk review, the verification body will review the data in annual monitoring reports to check calculations and information for reasonability, accuracy, and completeness.

Table 9.3. Desk Review Verification Items

Verification Items		Section of FPP	Apply Professional Judgment?
1. Attestation of Title	Proof that a signed Attestation of Title is on file at the Reserve for the dates of the verification period. In addition to reviewing this form, the verification body must conduct a review to confirm ownership and claims to GHG reductions/removals that have occurred over the verification period.	3.7	Yes
2. Attestation of Regulatory Compliance	Proof that a signed Attestation of Regulatory Compliance form is on file with the Reserve for the reporting period. In addition to reviewing this form, the verification body must perform a risk-based assessment to confirm the statements	3.8	Yes

Verification Items		Section of FPP	Apply Professional Judgment?
	made by the Project Operator in the Attestation of Regulatory Compliance form.		
3. Attestation of Voluntary Implementation	Proof that a signed Attestation of Voluntary Implementation form is on file with the Reserve for the reporting period. Required for every reporting period for Improved Forest Management projects, and for initial reporting periods only for Reforestation and Avoided Conversion projects.	3.3	No
4. Maintenance of Standing Live Carbon Pool	No decrease has occurred in the Project Area's standing live carbon stocks over any ten-year consecutive period not accounted for by allowable exceptions.	3.9.3	No
5. Estimates of Actual Onsite Carbon Stocks	Reported onsite carbon stocks are within expected bounds given reported harvest, growth, and disturbance effects since the prior reporting period.	6.1.3, 6.2.4, 6.3.3, Quantification Guidance	Yes
6. Estimates of Actual Carbon in Harvested Wood Products	The reported amount of wood that has been delivered to mills over the reporting period is consistent with reported harvest levels, and the amount of carbon expected to be transferred to wood products and stored over the long-term (100 years) has been calculated correctly, per the requirements in Section 6 and the requirements and the Quantification Guidance (see Section 9.3.8 for further verification guidance).	6.1.4, 6.2.5, 6.3.4, Quantification Guidance	Yes
7. Quantification of Primary Effect	Calculations for the Primary Effect are complete and accurate for both onsite carbon stocks and harvested wood products.	6	No
8. Quantification of Secondary Effects	Calculations for quantifying Secondary Effects are complete and accurate.	6.1.5, 6.2.6, 6.3.5	No
9. Reversal Determination	If a reversal has occurred, the type of reversal (avoidable or unavoidable) has been properly identified.	7.3	Yes
10. Reversal Risk Rating	Reversal risk rating is the same used since the previous site visit verification.	Appendix A	No

9.3.4 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). At a Forest Project's first site visit verification and at all subsequent site visit verifications, the verification body must evaluate the project against the Natural Forest Management criteria described in Section 3.9.2, referencing the most current Assessment Area Data File available on the Forest

Project Protocol webpage. Forest project carbon stock inventories (requirements for which are contained in the Quantification Guidance) should be used as the basis of these assessments where applicable. Forest projects that do not initially meet Natural Forest Management criteria but can demonstrate progress towards meeting these criteria within the required timelines are eligible to register and maintain that registration with the Reserve.

Table 9.4. Natural Forest Management Verification Items

Verification Items		Apply Professional Judgment?
1. Native Species	Completed inventory demonstrates that project consists of at least 95% native species. Must demonstrate continuous progress toward goal and criterion must be met within 50 years.	Yes
2. Composition of Native Species	a. Reforestation Projects: Documentation on planted mixture of species combined with natural regeneration meets composition of native species goals. Project must show continuous progress and criteria must be met within 50 years, unless an exception has been made through a letter from the State Forester as described in Section 3.9. b. Improved Forest Management and Avoided Conversion Projects: Completed inventory demonstrates distribution of average basal area of standing live tree species meets composition of native species goal. Project is not eligible unless it is demonstrated that management activities will enable this goal to be achieved over the project life or an exception has been made through a letter from the State Forester as described in Section 3.9.	Yes
3. Sustainability of Timber Resource	a. Documentation showing that the forest, including entity lands outside Project Area, is currently under one of the following: i. Third party certification under the Forest Stewardship Council or Sustainable Forestry Initiative/ Tree Farm System, or ii. A renewable long-term management plan sanctioned and monitored by a state or federal agency within a Reserve-approved Assessment Areas, or iii. For Project Operators and their affiliates that own 5,000 acres or less, uneven-aged silvicultural practices (if harvesting occurs) and canopy retention averaging at least 40% across the entire forestland owned by the Project Operator in the same Assessment Areas covered by the Project Area, as measured on any 20 acres within the Project Operator's landholdings found in any of these Assessment Areas, including land within and outside of the Project Area (areas impacted by Significant Disturbance may be excluded from this test), or iv. Possessing a deeded conservation easement(s) that contain terms that ensure growth equals or exceeds harvest over time. Verifiers should make a reasonable attempt to contact the steward of the conservation easement to confirm compliance. b. Completed inventory demonstrates the project maintains, or makes progress toward maintaining, no more than 40% of forested acres in ages less than 20 years. Project must show continuous progress and this criterion must be met within 25 years.	Yes
4. Structural Elements (Lying and Standing Dead Wood)	Completed inventory work demonstrates that lying and standing dead wood is retained in sufficient quantities and for sufficient duration depending on whether portions of the Project Area have undergone salvage harvesting.	Yes

9.3.5 Verifying Carbon Inventories

Verification bodies are required to verify carbon stock inventory estimates of all sampled carbon pools within the Project Area. Inventories of carbon stocks are used to determine the project baseline and to quantify GHG reductions and removals against the project baseline over time. Verification of carbon inventories consists of ensuring the Project Operator's sampling methodology conforms to requirements listed in the protocol and that the project's inventory sample plots are within specified tolerances when compared to the verifier's sample plots. Verification is effectively an audit to infer that the inventory estimate is sound. Verification of the project's onsite stocks must occur at each site verification and focus on ensuring that the project's inventory methodology is technically sound and that the methodology has been correctly implemented.

The project must meet the inventory standards in Table 9.6 prior to the verification body initiating field sampling activities. The verifier will install sample plots or re-measure existing monumented sample plots consistent with the objectives of a random, risk-based, and efficient approach.[22] In doing so, the verifier may weigh the probability of selecting strata and plots based on various criteria – including carbon stocking, access difficulty, and vegetation heterogeneity. Verifiers may choose to sample project plots within a given stratum with a cluster design. The selection of a stratum may use probability proportional to carbon stocks or probability proportional to the risk of errors (as hypothesized by the verifier).

9.3.5.1 Sequential Sampling for Verification

As a policy to ensure a trend of agreement with sampled data is sustained between the verifier and Project Operator, this protocol requires a sequential sampling method for verification of project estimates. Sequential sampling is intended to provide an efficient sampling method for verifiers to determine if randomly selected project measurements are within specified tolerance bounds established by the protocol.

Verification using the sequential sampling methodology requires the verification body to sequentially sample successive plots. Sequential approaches have stopping rules rather than fixed sample sizes. Verification is successful after a minimum number of successive plots in a sequence indicate agreement. Where the stopping rules indicate the potential presence of a bias, additional verification plots may be collected after that time if it is felt that random chance may have caused the test to fail and a convergence towards agreement is expected with additional verification samples. The results of any additional verification plot may also be inconclusive and require additional verification plots for a determination to be made. For effective application of the sequential statistics in the field, the determination of when the stopping rule is met is done at the end of each sampling day or when convenient for the verification team, which will include the full set of plots measured in that timeframe.

Worksheets are provided for use by verifiers to assist in verifying sampled data. The verifier will review the descriptive statistics of the carbon stocks independently for each pool or combination of pools that is being reported for crediting (applicable pool) as shown below:

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[22] For the purposes of this verification guidance the following terms and definitions apply:

1. Stand: An individual unit or polygon that is relatively homogeneous in terms of the carbon stocking within its borders. For live and dead trees, the determination of stand boundaries is usually based on forest vegetation attributes, such as species, size (age), and density characteristics. For soils, the determination of soil stand boundaries is made on similar soil orders.
2. Stratum: A group of stands that contain a similar attribute, such as vegetation or soils attributes.
3. Strata: Plural of stratum. The set of different groupings for a specific attribute, such as vegetation or soil.

- Standing live and dead trees
- Soil

To increase efficiency in the verification process, three different levels of sequential sampling are performed by the verifier. All tests are performed with the same randomly selected plots and can only be completed by analysis of the plots in the sequential order they were selected. The data identified below used for each test are input into the appropriate sequential sampling tool.

- Diameter Test: A comparison of diameter data between the verifier and the Forest Owner is conducted on a tree by tree basis until sequential sampling stopping rules have been achieved, indicating that the verifier and Forest Owner measurements of diameter are aligned within acceptable tolerance levels. If and when the stopping rules are met, verifiers will use the diameter data provided for each tree from the Forest Owner's database for any additional data inputs needed for the CO_2e/acre comparison.
- Height Test: Like the diameter test, a comparison of height data is performed between the verifier and the Forest Owner until sequential sampling stopping rules have been achieved, indicating that the verifier and Forest Owner measurements of height are aligned within acceptable tolerance levels. If and when the stopping rules are met, verifiers will use the height data provided for each tree from the Forest Owner's database for any additional data inputs needed for the CO_2e/acre comparison.
- CO_2e/acre: The testing of inventory data can only be satisfied when the CO_2e/acre comparison between the verifier and Forest Owner is completed. This test is conducted on a plot by plot basis using estimates of CO_2e/acre. The verifier's estimates of CO_2e/acre are derived by measurements of diameter and height (measured by verifier or using Forest Owner's data, as described above), species determination, defect and decay determination, and a determination of the appropriate trees to be included in the sample ('in' or 'out' trees).

Separate worksheets have been developed to assess both monumented (paired) and non-monumented (unpaired) plots as well as for DBH, height, and CO_2e/acre. Worksheets are found on the Forest Project Protocol webpage.

The Reserve has established a ten percent allowance as an acceptable level of agreement between the verifier and the Project Operator, without adjusting the project estimates for uncertainty.

9.3.5.2 Inventory Estimates

The items in Table 9.5 are evaluations that should be made before the verifier goes to the field and analyzes the plots. If a project opts to utilize the Reserve's Standardized Inventory Methodology, the methodology need not be assessed beyond correct implementation.

Table 9.5. Inventory Methodology Verification Items

Verification/Evaluation Standards		Insert a 'Failure to Meet Standard' in any category below where the standards on the left are not met or clearly have not been implemented as described in the inventory methodology
1.a	Inventory methodology describes the methodology for plot location in the field. The plot locations are either random or systematic with a random initial point.	X
1.b	If inventory methodology describes a stratification design: The stratification methodology, including rules for stratification, is clearly defined. The stratification design is relevant for the sampling of biomass. In particular, the stratification design applies to all tree species without a bias for commercial tree species. Verifier shall randomly select 10% of the vegetation units, or strata polygons, by area, or 500 acres (whichever is least) to evaluate that the vegetation (or stratum) label assigned to the polygon is consistent with the stratification rules documented in the inventory methodology. The selection shall be made from a database or spreadsheet list of all vegetation (stratum) polygons within the project that have not experienced a harvest or disturbance that affects carbon stocks by more than 10%, using verifier judgment, within the past 10 years. Evaluation of post-harvest polygons and plots is described in 1.c. Evaluation for consistency shall be conducted through comparison with aerial photos or other remotely sensed data, and/or field observation. During evaluation, a verifier must use professional judgment to determine if a polygon is consistent or inconsistent with the stratification rules. Inconsistent means the existing vegetation (stratum) label is grossly incorrect to an extent that would substantially alter the associated carbon stocks. If more than 10% of the polygons evaluated are determined to be inconsistent with the stratification rules documented in the inventory methodology, the verification shall expand the assessment to an additional 10% of the vegetation units (stratum polygons), or an additional 500 acres (whichever is least) and expand the analysis, or determine that the project has failed to meet the standard.	X
1.c	Inventory methodology states how the inventory is updated on an annual basis to reflect growth, harvest, and other disturbances. An event is deemed to be a disturbance, whether natural or the result of human activities, if the event results in an estimated loss of more than 10% of the pre-disturbance carbon stocks in the applicable carbon pools. The methodology includes a process to: ▪ Update the inventory for harvest and other disturbances. The immediate updating of an inventory for disturbances will require that a tree list is assigned to the area disturbed, rather than developing a tree list from field measurements, to represent the area disturbed. This may occur by assigning a vegetation label (stratifying) and compiling the inventory so that the area disturbed obtains a tree list representative of the disturbed condition. For stratified inventories, this may be a solution that lasts many years until the forest vegetation is re-stratified due to changes from forest growth. Immediately	X

	updating an inventory may also occur by assigning a 'best-fit' tree list that represents the stand conditions to the plots that were affected by disturbance. This solution is a shorter term solution since the plots used to estimate the inventory have been affected. During all site visit verifications (following the initial site visit verification in cases where the project start date is the same year as the initial site visit verification),the Project Operator must provide a map(s) that displays areas where disturbance has occurred. For stratified inventories, a pre-disturbance map must display the vegetation stratum prior to the disturbance and a post-disturbance map must display the vegetation stratum following the disturbance. For non-stratified inventories, the disturbance map must display the underlying plots, if any, affected by the disturbance. For stratified inventories, a summary tree list associated with the updated vegetation strata shall be provided. For non-stratified inventories, tree lists shall be provided for each plot affected by disturbance. During site verification, verifiers shall randomly select a minimum of 10% of the vegetation polygons (strata polygons) or plots updated for disturbance, and determine if the assigned tree lists do not obviously overestimate the carbon associated with the forest structure remaining after the disturbance. Where plots are updated through assignment of a tree list (instead of assigning a vegetation stratum) following the disturbance, the verifier shall ensure all plots have been updated and the updated tree list is consistent with the forest structure remaining after disturbance. For non-stratified inventories, it is not acceptable for a Project Operator to simply remove disturbed plots from the inventory. The plots must be assigned a tree list to estimate the post-disturbance condition. It is acceptable to remove plots from an inventory that is strata-based upon disturbance that affects the plots. Tree lists resulting from stratification or assignment are determined to be inconsistent if the tree list would result in carbon stocks substantially above what in the verifier's professional judgment would associate with the post-disturbance condition. The determination for consistency can be made through an office review by comparing the assigned tree lists with the disturbance events. A verifier can choose to enhance their review for consistency by visiting disturbed sites in the field. To minimize the risk of inaccuracies to the inventory, no more than 10% of the plots used to characterize the project's inventory can be developed from estimated tree lists without increased scrutiny from verification. The plots assigned an estimated tree list must be appropriately coded in the inventory database so that they can be queried and isolated. Plots assigned with an estimated tree list are not to be used in sequential sampling efforts unless the number of plots with estimated tree lists exceeds 10%, in which case all plots, measured or estimated, must be available for random selection for sequential sampling during verification. ▪ Update the inventory for growth using and approved growth model or a stand table projection, as described in the Quantification Guidance. The inventory being verified is determined to be current using the update methodology.	

1.d	The inventory methodology has been implemented in a consistent manner since the project's inception. If changes have been made to the inventory methodology, such changes have been discussed and approved in writing by the Reserve.	X
1.e	The inventory methodology describes the volume and biomass equations used to compute the project's carbon stocks and these equations are consistent with those required by the protocol. Appropriate use of biomass equations is demonstrated.	X

Each applicable pool/combination of pools must meet the minimum precision threshold of +/- 20 percent at the 90 percent confidence interval. Project Operators can improve the precision of their estimates through additional inventory effort, but can only include it in their reporting after the confidence estimate has been verified. Projects must include the uncertainty adjustment associated with their most recent verification effort. The emissions associated with site preparation activities (soil, shrubs, and herbaceous understory) are not subject to the same sequential sampling requirements and shall be verified according to the guidance for estimating site preparation emissions for reforestation projects in the online Quantification Guidance.

Use of the Standardized Inventory Methodology (available on the Reserve's Forest Project Protocol webpage) will be considered to automatically meet the evaluation standards in Table 9.5 and does not need to be verified beyond ensuring proper implementation. The Reserve has also developed the Climate Action Reserve Inventory Tool (CARIT), an inventory management computer application that Project Operators may also optionally use to manage and update their forest inventories. The use of the Standardized Inventory Methodology does not obligate a Project Operator to use CARIT, nor does the use of CARIT obligate a Project Operator to use the Standardized Inventory Methodology. However, CARIT will only function properly if certain inventory standards are followed. Refer to the Quantification Guidance for more information.

9.3.5.3 Measurement Specifics for Verifiers

Verifiers must use the highest standard to conduct measurements during field measurements. Measurements utilized by verifiers during field inspections shall be consistent with the tolerance standards for measurements identified in the Quantification Guidance, with the following exceptions:

1. Verifiers shall measure the heights of all trees according to the height measurement used for the species-specific biomass equation on the Reserve's Forest Project Protocol webpage.
2. The use of regressions to estimate heights is allowable for Forest Operators; verifiers should measure each height for comparisons with Forest Operator's estimates.
3. Tools and methods used for distance measurements for plot boundaries should be accurate within 1"/30'.
4. Tools and methods used for distance measurements for height measurements must be able to obtain an accuracy of 6"/100'.
5. Rules for determining 'in'/'out' trees:
    a. All borderline trees should be measured to determine status as an 'in' or 'out' tree.
    b. Verifiers may encounter trees that are 'in' that were not measured by the Project Operator. The cause of the omission(s) may be that the trees were determined to

be too small to be included, per sampling methodology criteria, at the time of the Project Operator measurement. Per the Quantification Guidance, inventory estimates developed by the Project Operator must include all trees 5 inches DBH and larger.

c. Additionally, the Quantification Guidance permits Project Operators to develop an inventory methodology with varying plot areas that are expanded on a per acre basis depending on the size of the plots and with varying DBH requirements for which trees are included in each plot. In such cases, trees that were determined to be too small to be included in a larger plot by the Project Owner, may have grown and now exceed the minimum threshold for inclusion in the larger plot.

d. To account for this limited growth, the verifier shall not include trees in the verifier measurements (for sequential sampling purposes) if the tree was omitted by the Forest Owner and the tree diameters, at time of verification audit, are less than 7 inches DBH. Similarly, trees that were included by the Forest Owner in a plot with a certain expansion factor and, at the time of verifier audit, have not exceeded the threshold for being switched to a plot with a different expansion factor by more than 10%, shall continue to be entered in the plot determined by the Project Operator, such that the expansion values are consistent for the Project Operator and the verifier.

   i. This applies a reasonable cushion to Project Operators who apply the sampling methodology correctly, but through no fault of their own would otherwise be penalized due to forest growth changing measurement parameters. It should be noted that the cushion is minimal and will not relieve Project Operators from growth over long periods of time that would exceed these allowances. Hence, Project Operators need to base the re-measurement of the plots on an adequate timeframe to avoid verification problems with their inventory data.

   ii. Any trees that do not meet the criteria of the standards listed above shall be included as part of the verifier's plot estimate for purposes of sequential sampling.

6. Verifiers shall insert their own determination of species for each tree included in the verifier's inventory.

7. For defect and decay, verifiers may first consider the inputs of the Forest Owner and determine whether or not they were reasonable. If considered reasonable, the verifier may insert the same classification as the Forest Owner for each tree included in the verifier's inventory. If, however, not considered reasonable, or not recorded by the Forest Owner, the verifier shall insert their own determination.

9.3.5.4 Verifying a Stratified Inventory

Where the Project Operator's inventory is stratified, the strata to be verified may be selected by the verifier according to the presumed risk of measurement error or presumed risk of the effects of measurement error on the overall inventory estimate, as described above. Individual stands and/or plots must be independently selected using a random selection design. The verifier shall select three strata (or the maximum number of strata present) based on the verifier's evaluation of risk. The minimum number of passing plots is six consecutive passing plots, or the first passing plot after a minimum of twelve plots are measured.

9.3.5.5 Verifying a Non-Stratified Inventory

If the project is not stratified for each applicable pool, the verifier shall select the plots randomly (if plot locations can be relocated) or allocate the plots systematically or in clusters for efficiency. Where plots can be relocated, the plots available for selection shall adhere to the guidance in Table 9.5 (1.c) with regards to updating inventories based on disturbance events. If the verifier uses a cluster design as part of the systematic allocation of plots, the mean of the cluster accounts for one observation (plot). Plots may be measured and assessed one at a time or in reasonable batches that correspond to logistical realities such as crew-days of effort. Sequential sampling is passed when the first passing plot is reached after a minimum of thirty measured plots.

9.3.5.6 Verification Within a Stand

Plots or clusters must also be independently selected using a random or systematic design. No more than six plots or clusters can be assigned to a stand, unless the groups of plots required for verification exceed the number of stands that exist for the project.

There are two possible statistical procedures that can be applied to the stratum-level verifications. A paired test can be applied when plot locations can be found and it is statistically appropriate to use a paired test (i.e., plot measurements can be replicated). An unpaired test can be applied when plots cannot be relocated. The range of acceptable error (δ, delta) is fixed at ten percent for both tests.

Paired Plots

The statistical test is based on a comparison of the verifier's measurements of plots within a selected stratum, calculated as CO_2-e compared to the Project Operator's measurements of plots, which may include any adjustments for growth.

Use **α=0.05** and **β=0.20** to control for error.

The null hypothesis (H_0) is that the verification and project plots are equal.

1) Perform verification sampling on at least the minimum number of passing plots required in a sequence from Section 9.3.5.4.

2) If $\mathbf{n \geq ((Z_\alpha + Z_\beta)^2 \times S_n^2) / D^2}$ then stop and evaluate. Otherwise take another sample.

   n = Number of verification plots measured
   $Z_\alpha = \alpha\%\ N(0,1) = 1.645$
   $Z_\beta = \beta\%\ N(0,1) = 0.8416$
   S_n^2 = sample variance of the differences
   D = δ × project average estimate

3) If stopped, then evaluate.

   If $\bar{X}_N \leq K$ then accept H_0,
   If $\bar{X}_N > K$ then reject H_0.

   $\bar{X}_N$ = sample mean of the differences
   N = total number of plots measured
   $K = (Z_\alpha \times D) / (Z_\alpha + Z_\beta)$.

4) If H_0 was rejected then additional samples may be taken as long as the verifier is of the opinion that there is a chance that H_0 may be accepted based on the variability and trend observed.

Unpaired Plots

The statistical test is based on comparing the average CO_2e estimates for each stratum from the verifier plots to the Project Operator plots.

Use **α=0.05** to control for error; the β is not specified because we are constructing a confidence interval not a test. The null hypothesis (H_0) is that the verification and stratum averages are equal. The following procedure is appropriate for the unpaired test.

1) Perform verification sampling on at least the minimum number of plots required in a sequence from Section 9.3.5.5. Calculate n as the sum of the number of plots from both the stratum and the verification.

2) Calculate the following:

   $T_n = \bar{X}_P - \bar{X}_n$

   Where,
   $\bar{X}_P$ = stratum mean,
   $\bar{X}_n$ = verification mean after sample n.
   S_n^2 = sample variance of the verification plots,
   S_P^2 = sample variance of the stratum plots,
   D = δ × stratum average estimate.

3) If $\mathbf{n \geq (a^2/D^2) \times (S_n^2 + S_P^2)}$ then stop and evaluate. (Note: $n = n = n_P + n_V$). Otherwise take another sample.

4) If stopped, then evaluate. Construct a confidence interval $T_n \pm D$.
   If the confidence interval includes zero then accept H_0,
   Otherwise reject H_0.

5) If H_0 was rejected then additional samples may be taken until as long as the verifier is of the opinion that there is a chance that H_0 may be accepted based on the variability and trend observed.

If the stopping rule in step (3) above cannot be attained within 100 plots then apply a standard unpaired t-test comparison using alpha of 0.05 and beta of 0.80.

9.3.6 Step-by-Step Guidelines for Performing the Verification

Step1: Assigning Risk to Strata

The verifier must determine for standing live and standing dead trees if the Project Operator has stratified the Project Area into strata that reflect common characteristics that influence carbon stocks. The verifier may presume risk exists in the highest stocked strata, strata that are unique or difficult to access due to topographical, vegetative, or other physical barrier, strata that represent a large portion of the project's inventory due to the area they represent, or any other risk perceived by the verifier. The determination of risk must be applied to the stratum as a unit and not individual stands of a given stratum.

Step 2: Selecting Strata Based on Risk

Based on the assessment of risk, the verifier will query or request that the Project Operator query the set of stands that are associated with the strata selected. The queried stands must have an identifier which can be based on the Project Operator's identification convention or one assigned by the verifier. Three strata must be selected, or the maximum number of strata stratified by the Project Operator for each pool. Table 9.6 displays an example of ordered strata for standing live and dead trees selected by stratum with random numbers assignments.

Table 9.6. Stands Selected by Vegetation Strata and Risk Class with Random Number Assignments

Stand Number	Stratum (from Project Operator or Verifier)	Risk Class	Order of Random Selection
2	Dense Intermediate Conifers	High Stocking	5
3	Dense Intermediate Conifers	High Stocking	3
4	Dense Intermediate Conifers	High Stocking	1
8	Dense Intermediate Conifers	High Stocking	8
9	Dense Intermediate Conifers	High Stocking	2
10	Dense Intermediate Conifers	High Stocking	1
15	Dense Intermediate Conifers	High Stocking	4
18	Dense Intermediate Conifers	High Stocking	7
Stand Number	**Stratum (from Project Operator or Verifier)**	**Risk Class**	**Order of Random Selection**
8	Dense Mature Conifers	High Stocking	4
9	Dense Mature Conifers	High Stocking	3
10	Dense Mature Conifers	High Stocking	5
15	Dense Mature Conifers	High Stocking	2
18	Dense Mature Conifers	High Stocking	1
Stand Number	**Stratum (from Project Operator or Verifier)**	**Risk Class**	**Order of Random Selection**
13	Medium Dense Mature Riparian	Difficult Access	2
14	Medium Dense Mature Riparian	Difficult Access	1
17	Medium Dense Mature Riparian	Difficult Access	3

Step 3: Planning and Implementing Field Verification Sampling

The selected stands should be mapped and labeled with the random number to assist in developing a strategy to perform field sampling activities. Up to six plots or clusters may be re-measured in a stand (if plots are monumented by the Project Operator) or installed (if plots are not monumented) in each stand. If the Project Area has not been stratified or there are less than three strata, the verifier shall locate the plots or clusters using a random process of their own design. For efficiency, it is acceptable for the verifier to relocate to a new area at the beginning of a day without having completed all the plots in the previous day.

Step 4: Determining if the Stopping Rules Have Been Met

The verifier must determine if the stopping rules have been met for each stratum after the measurement of each plot or at a minimum the end of each day. The Reserve provides tools to assist verifiers with determining if the stopping rules have been met or not. The tools are Microsoft Excel based and are distinct for paired designs and for unpaired designs.

The verifier must enter their data into the appropriate spreadsheet based upon use of a paired or unpaired test. It is required that the verifier apply the random order selection in the sampling process. The verifier is free to measure the set of plots that were randomly selected in any order that provides the greatest efficiency while sampling in the field, but when the verifier inputs data into the spreadsheet, the verifier must follow the random selection order in order to properly conduct the analysis and maintain the integrity of sequential analysis. This may provide significant efficiencies when selected stands and/or plots are in close geographic proximity and it is hypothesized that the stopping rules will require the full number of plots. Table 9.7 displays a hypothetical sampling schedule planned by the verifier and the hypothetical verification results. In this case, the sequential sampling is conditionally satisfied after Day 3 but requires the full set of randomly selected stands to be sampled up to the point of satisfying the sequential statistics, which is met after sampling Stand 3 on Day 4.

The statistical test is based on a comparison of the verifier's measurements of plots, calculated as CO_2e per acre compared to the Forest Owner's measurements of plots, which may include any adjustments for growth. The inventory verification is complete when the first plot passes after a minimum of 12 plots are measured, or when a minimum of 6 plots are identified as 'passing' in sequence in the Sequential Sampling Tool for plot CO_2e per acre (paired) or when the first plot passes after a minimum of 30 plots are measured (unpaired). Passing of the plot height and/or diameters (DBH) is not required to pass the inventory verification; however, as discussed above, verifiers may separately compare their measurements for height and diameter with the Forest Owner's measurements in the sequential sampling tool. When 6 consecutive plots are identified as 'passing' for either height or diameter, that input is then considered to have met sequential sampling requirements and verifiers may use the data provided for each tree from the Forest Owner's database for any additional data inputs needed for the CO_2e/acre comparison.

Table 9.7. Example of Randomly Selected Plots

Stand	Stratum (from Forest Owner)	Risk Class	Order of Random Selection	Sampling Schedule (Planned)	Verification Effort	Verification Results
4	Dense Intermediate Conifers	High Stocking	1	Day 3	Day 1	Inconclusive. Stand 9 sampled. Sequential sampling criteria not satisfied - More plots are needed
9	Dense Intermediate Conifers	High Stocking	2	Day 1	Day 2	Inconclusive. Stand 15 sampled. Sequential sampling criteria not satisfied - More plots are needed
3	Dense Intermediate Conifers	High Stocking	3	Day 4	Day 3	Inconclusive. Stand 4 sampled. Sequential sampling criteria satisfied but stand order must be satisfied. Stand 3 must be sampled
15	Dense Intermediate Conifers	High Stocking	4	Day 2	Day 4	Conclusive. Stand 3 sampled. Sequential sampling criteria is met and adherence to random selection is maintained
2	Dense Intermediate Conifers	High Stocking	5	Day 6		
10	Dense Intermediate Conifers	High Stocking	6	Day 5	Further Verification Effort not Necessary	
18	Dense Intermediate Conifers	High Stocking	7	Day 7		
8	Dense Intermediate Conifers	High Stocking	8	Day 8		

Finally, in addition to evaluating and verifying adherence to the Project Operator's inventory methodology, the verification body must verify the items in Table 9.8.

Table 9.8. Additional Verification Items for Inventory Methodology and Implementation

Verification Items		Apply Professional Judgment?
1. Inventory Update Processes	a. Project Operator's inventory document describes methodology for updating inventory data resulting from growth, harvest, and disturbances. Methodology adheres to acceptable forestry practices.* b. Harvest/Disturbance updates in inventory management system are implemented per the specified methodology and are representative of the harvest or disturbance. c. Growth is accounted for using an approved growth model or using a stand table projection, as described in the Quantification Guidance.	Yes

2. Biomass Equations and Calculations	a. The carbon tonnes per acre for a representative sample plot, computed using the Project Operator's calculation tools, replicate output computed by the verification body.** b. All conversions and expansions are accurate.	Yes

*A forest biometrician employed by the state in which the project is located, or a consulting forest biometrician may be consulted in the event of a dispute between the verification body and Project Operator. The written opinion of the forest biometrician, submitted to the Reserve as part of the verification report, shall be considered the authoritative word.

**The verification body must provide an (idealized) 'verification plot' consisting of all tree species in Project Area with varying heights and diameters existing within the Project Area. The plot need not correspond to an actual plot within the Project Area.

9.3.7 Baseline Modeling

To determine a Forest Project's baseline, computer models are used to project the Project Area's initial inventory of carbon stocks into the future under a set of constraints prescribed by this protocol (Section 6). Modeling must include assumptions about forest growth and harvest, as influenced by legal and financial constraints, and assumptions regarding the extent of harvest operations under Business As Usual conditions.

Verification bodies are required to verify the baseline estimate for the project at the initial site visit verification for Improved Forest Management Projects and Avoided Conversion Projects. Reforestation baselines may be verified at the second site visit verification.

Baseline modeling must incorporate initial inventory estimates and forecast how carbon stocks will change over the Forest Project's crediting period.

All reports that reference carbon stocks must be submitted by the Project Operator 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 http://www.certifiedforester.org) are required so that professional standards and project quality are maintained.

Table 9.9. Baseline Modeling Verification Items

Verification Items		Section of FPP	Apply Professional Judgment?
1. Document	A modeling document exists that contains all the verification items in this table.	9	No
2. Qualitative Characterization (Reforestation and Avoided Conversion Projects Only)	A sufficiently detailed qualitative characterization has been included in the modeling document that documents the general assumptions of the project's baseline. The qualitative assessment addresses the vegetative conditions and activities that would have occurred.	6.1, 6.3	Yes

Verification Items		Section of FPP	Apply Professional Judgment?
3. Model Choice and Calibration	a. The model used is an approved model. b. The Project Operator has provided a rationale for any model calibrations or a sufficient explanation of why calibrations were not incorporated. c. The Project Operator has provided a description of the site indexes used for each species and a sufficient explanation of the source of the site index values used.	Quantification Guidance	Yes
4.Legal Constraints	A list of legal constraints is provided that includes an accurate description of the type and effect of each constraint on the ability to harvest trees and the area constrained.	3.3.1, 6.1.1, 6.2.1, 6.3.1	Yes
5. Financial Constraints	a. A sufficient qualitative description is provided indicating that the harvesting activity modeled in the baseline is a financially viable activity. b. For Improved Forest Management projects, Project Operator has provided either 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.	3.3.2, 6.1.1, 6.2.2, 6.3.1	Yes
6. Silviculture Guidelines	The silviculture guidelines incorporated in the model demonstrate all legal constraints are applied in the model. The silviculture guidelines must include: i. A description of the trees retained by species group ii. The level of retention iii. Harvest frequency iv. Regeneration assumptions	Quantification Guidance	No
7. Modeling Guidelines	a. Reforestation: Modeling is based on the qualitative characterization of the baseline and conducted per Section 6.1. b. Improved Forest Management: Modeling is conducted per Section 6.2. c. Avoided Conversion: Modeling is conducted per Section 6.3.	6.1, 6.2, 6.3	No
8. Modeling Outputs	a. The Project Operator has provided reports that display periodic harvest, inventory, and growth estimates for the entire Project Area presented as total carbon tonnes and carbon tonnes per acre. b. Estimates are within the range of expected growth patterns for the Project Area.	9, Quantification Guidance	Yes

9.3.8 Verifying Estimates of Carbon in Harvested Wood Products

Verification bodies are required to verify the estimates of carbon that are likely to remain stored in wood products over a 100-year period, as submitted in the Forest Project Design Document (for baseline estimates) and annual monitoring reports (for actual wood product production). 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.

Table 9.10. Carbon in Harvested Wood Products Verification Items

Verification Items		Section of FPP	Apply Professional Judgment?
1. Carbon in Harvested Wood Delivered to Mills	a. Amount of wood harvested that will be delivered to mills has been estimated and reported. b. The appropriate wood density factor has been applied and/or water weight subtracted to result in pounds of biomass with zero moisture content. c. Total dry weights for all harvested wood have been calculated. d. Total carbon weight has been computed. e. The total has been converted to metric tons of carbon.	Quantification Guidance	No
2. Account for Mill Efficiencies	The correct mill efficiency factors have been used to calculate total carbon transferred into wood products.	Quantification Guidance	No
3. Wood Product Classification	The percentages of harvest by wood product class has been determined correctly with verified reports from the mill(s) where the Project Area's logs are sold; or by looking up default wood product classes for the project's Assessment Area(s); or if not available from either of these sources, by classifying all wood products as "miscellaneous."	Quantification Guidance	No
4.Calculation of In-Use and Landfill Carbon Storage	a. The average amount of carbon stored in in-use wood products over 100 years has been calculated correctly using the worksheets in the Quantification Guidance. b. The average amount of carbon stored in landfilled wood products over 100 years has been calculated correctly using the worksheets in the Quantification Guidance.	Quantification Guidance	No
5. Total Average Carbon Storage in Wood Products Over 100 Years	Total average carbon storage in wood products over 100 years for a given harvest volume has been calculated and reported.	Quantification Guidance	No

9.3.9 Verifying Calculations of Reversal Risk Ratings and Contributions to the Buffer Pool

At each site visit verification, Project Operators must derive a reversal risk rating for their Forest Project using the worksheets in Appendix A. The worksheets are designed to identify and quantify the specific types of risks that may lead to a reversal, based on project-specific factors.

Table 9.11. Reversal Risk Rating Verification Items

Verification Items		Section of FPP	Apply Professional Judgment?
1. Financial Risk	Use of a Qualified Conservation Easement or Qualified Deed Restriction, occurrence on public lands, or use of a PIA alone.	Appendix A.1	No
2. Management Risk	a. Management Risk I – Illegal removals of forest biomass. b. Management Risk II – Conversion of Project Area to alternative land uses. c. Management Risk III – Over-harvesting.	Appendix A.2	No
3. Social Risk	Social Risk.	Appendix A.3	No
4. Natural Disturbance Risk	a. Natural Disturbance Risk I – Wildfire. b. Natural Disturbance Risk II – Disease or insect outbreak. c. Natural Disturbance Risk III – Other episodic catastrophic events.	Appendix A.4	Yes
5. Completing the Risk Rating Analysis	Reversal risk rating calculated correctly using the formula in Appendix A.5.	Appendix A.5	No

9.4 Completing the Verification Process

After completing the core project verification activities for a Forest Project, the verification body must do the following to complete the verification process:

1. Complete a Verification Report to be delivered to the Project Operator (public document).
2. Complete a detailed List of Findings containing both immaterial and material findings (if any), and deliver it to the Project Operator (private document).
3. Prepare a concise Verification Statement detailing the vintage and the number of GHG reductions and removals verified, and deliver it to the Project Operator (public document).
4. Verify that the number of GHG reductions and removals, as well as the reversal risk rating, specified in the Verification Report and Statement match the number entered into the Reserve software.
5. Conduct an exit meeting with the Project Operator to discuss the Verification Report, List of Findings, and Verification Statement and determine if material misstatements (if any)

can be corrected. If so, the verification body and Project Operator should schedule a second set of verification activities after the Project Operator has revised the project submission.

6. If a reasonable level of assurance opinion is successfully obtained, upload electronic copies of the Verification Report, List of Findings, Verification Statement, and Verification Activity Log into the Reserve.
7. Return important records and documents to the Project Operator for retention.

The recommended content for the Verification Report, List of Findings, and Verification Statement can be found in the Reserve's Verification Program Manual.[23] The Verification Program Manual also provides further guidance on quality assurance, negative verification statements, use of an optional Project Verification Activity Log, goals for exit meetings, dispute resolution, and record keeping.

[23] Available at http://www.climateactionreserve.org/how/program/program-manual/.

10 Glossary of Terms

Aboveground Live Biomass	Live trees including the stem, branches, and leaves or needles, brush, and other woody live plants aboveground.
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 requirement 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.
Affiliate	An “affiliate” is defined as any person or entity that, directly or indirectly, through one or more intermediaries, controls or is controlled by or is under common control with the Forest Owner(s) participating in a project, including any general or limited partnership in which the Forest Owner is a partner and any limited liability company in which the Forest Owner is a member. For the purposes of this definition, "control" means the possession, direct or indirect, of the power to direct or cause the direction of the management and policies of a person, whether through the ownership of voting securities, by contract or otherwise, and “person” means an individual or a general partnership, limited partnership, corporation, professional corporation, limited liability company, limited liability partnership, joint venture, trust, business trust, cooperative or association or any other legally-recognized entity.
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 belowground root volume to be estimated using the aboveground bole volume.
Assessment Area	A distinct forest community within geographically identified ecoregions 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 Project Operator's negligence, gross negligence, or willful intent, including harvesting, development, and harm to the Project Area
Avoided Conversion Project	A type of Forest Project consisting of specific actions that prevent the conversion of forestland to a non-forestland 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.[24]
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.[25]
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 tons of CO_2-equivalent).

[24] Helms. (1998).
[25] Metz, Davidson, Swart, & Pan. (2001).

Business As Usual	The activities, and associated GHG reductions 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 aboveground or belowground biomass or harvested wood products, among others.
Climate Reserve Tonne (CRT)	The unit of offset credits used by the Climate Action Reserve. Each Climate Reserve Tonne represents one metric ton (2204.6 lbs) of CO_2 reduced or removed from the atmosphere.
Commercial Harvesting	For the purpose of this protocol, commercial harvesting refers to harvesting activities undertaken by a Forest Owner with the intent to deliver to a mill.
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 percent 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 Carbon	The carbon found in forestland resulting from photosynthesis in trees and associated vegetation, historically and in the present. Forest Carbon is found in soils, litter and duff, plants and trees, both dead and alive.
Forest Management	The commercial or noncommercial growing and harvesting of forests.
Forest Owner	A corporation or other legally constituted entity, city, county, state agency, individual(s), or a combination thereof that has legal control (described in Section 2.2) of any amount of forest carbon within the Project Area

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 verification body and approved by the Reserve before the Forest Project can be registered with the Reserve.
Forestland	Land that supports, or can support, at least ten percent tree canopy cover and that allows 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 Gas (GHG)	Gas that contributes 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_2O), 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 Project Operator has created an account with the Reserve, submitted the required Project Submittal 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 five inches and a minimum

	length of eight feet. Anything not meeting the measurement criteria for lying dead wood will be considered litter. Stumps are not considered lying dead wood.
Metric Ton or “tonne” (t)	A common international measurement for the quantity of GHG emissions, equivalent to about 2204.6 pounds or 1.1 short tons.
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 Section 3.9.2.
Non-Forest Cover	Land with a tree canopy cover of less than ten 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.
Onsite Carbon Stocks	Carbon stocks in living biomass, dead biomass, and soils within the Project Area.
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 Effects	The Forest Project’s intended changes in carbon stocks, GHG emissions or 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 3.5.
Public Lands	Lands that are owned by a public governmental body such as a municipality, county, state or country.
Project Operator	A Forest Owner responsible for undertaking a Forest Project and registering it with the Reserve. The Forest Owner who executes the Project Implementation Agreement, as described in Section 2.2.
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 Project Operators for the full duration of the Forest Project's minimum time commitment, as defined in Section 3.5 of this protocol.
Qualified Deed Restriction	A qualified deed restriction shall ensure that the Project Implementation Agreement runs with the land and applies to all current and subsequent Project Operators for the full duration of the Forest Project's minimum time commitment, as defined in Section 3.4 of this protocol, to be determined in the Reserve's reasonable discretion. A deed restriction is not "qualified" if it merely consists of a recording of the Project Implementation Agreement or a notice of the Project Implementation Agreement, as such a recording is already required by the Project Implementation Agreement.
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 and ISO-accredited verification body, all required documentation (see Section 8) has been submitted by the Project Operator 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).
Reporting Period	The period of time over which a Project Operator quantifies and reports GHG reductions and removals.
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[26] and changes in forest management.
Significant Disturbance	Any natural impact that results in a loss of least 20 percent of the aboveground live biomass that is not the result of intentional or grossly negligent acts of the Project Operator.
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 aboveground live biomass, regardless of species, with a minimum diameter (breast height) of five inches and a minimum height of 15 feet (inventory methodology must include all trees five inches and greater)
Stocks (or Carbon Stocks)	The quantity of carbon contained in identified carbon pools.
Submitted	The Reserve considers a Forest Project to be "submitted" when all of the appropriate forms have been uploaded and

[26] Metz, Davidson, Swart, & Pan. (2001).

	submitted to the Reserve's software system, and the Project Operator has paid a project submission 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 five inches and a minimum height of 15 feet with no branches within three feet from the ground at maturity.[27]
Unavoidable Reversal	An unavoidable reversal is any reversal not due to the Project Operator's negligence, gross negligence or willful intent, including wildfires or disease that are not the result of the Project Operator'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 an ISO-accredited and Reserve-approved verification body, to confirm that the Project Operator has adhered to the requirements of this protocol.
Verification Period	The period of time over which GHG reductions/removals are verified. A verification period may cover multiple reporting periods. The end date of any verification period must correspond to the end date of a reporting period.

[27] Helms. (1998).

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

Project Operators 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. Reforestation Projects that defer the verification of an inventory until the second verification shall defer the determination of a reversal risk rating until the second verification when the project has a verified inventory.

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 affect only current and future year contributions to the Buffer Pool. The Reserve may, from time to time, transfer Climate Reserve Tonnes (CRTs) from the Buffer Pool to the Project Operator's account if the Reserve determines that previously assessed risk ratings were unnecessarily high. Alternatively, the Reserve may waive a Project Operator's future contributions to the Buffer Pool until excess contributions from previous years are recouped. If a Forest Project's risk rating increases, the Project Operator must contribute additional CRTs to the Buffer Pool to ensure that all CRTs (including those issued in prior years) are properly insured.

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

Table A.1. Forest Project Risk Types

Risk Category	Risk Type	Description	How Risk is 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
	Project Implementation Agreement (PIA) Subordination	Subordinating the PIA to mortgages or deeds on or affecting the Project	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	Project-specific Risk

Risk Category	Risk Type	Description	How Risk is Managed in this Protocol
	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

A.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 A.2. Financial Failure Leading to Bankruptcy

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

Table A.3. PIA Subordination

Applies to all projects		
Identification of Risk	**Contribution to Reversal Risk Rating**	
	PIA with "Subordination Clause Type II"	PIA with "Subordination Clause Type I"
Default Financial Risk	10%	2%

A.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 A.4. Risk of Illegal Removals of Forest Biomass

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
United States Default Harvesting Risk	0%

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 A.5. Risk of Conversion to Alternative Land Use

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
With Qualified Conservation Easement or Qualified Deed Restriction that explicitly encumbers all development rights or on public lands	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 A.6. Risk of Over-Harvesting

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
With Qualified Conservation Easement or Qualified Deed Restriction that explicitly encumbers timber harvesting associated with project stocks or on public lands	0%
Without Qualified Conservation Easement or Qualified Deed Restriction	2%

A.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 A.7. Social Risk Identification

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
United States Default Social Risk	2%

A.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 A.8. Natural Disturbance Risk I – Wildfire

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
Refer to the Assessment Area Data File for the project's risk rating	X%
If fuel treatments have been implemented for the Project Area, reduce the value above by the appropriate percent as indicated below.*	(X%) **x** Y%

* Depending on the level of fuel treatments the Y% is set as follows: project is actively implementing comprehensive fuel management plan, or implements a combination of fuel breaks in strategic areas and thinning from below across at least 30% of the project area = 50%, silviculture across at least 30% of the project area consists largely of thinning from below = 66.3%, project has installed fuel breaks in strategic areas = 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 A.9. Natural Disturbance Risk II – Disease or Insect Outbreak

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
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 A.10. Natural Disturbance Risk III – Other Episodic Catastrophic Events

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
Default Risk Contribution from Other Catastrophic Events	3%

A.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 A.11. 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[28]	Default Risk -Remedies for reversals addressed in PIA	15% or 7%	11% or 3%
Illegal Forest Biomass Removal	Default Risk	0%	0%
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 Table A.8	X% or (X% x Y%)	X% or (X% x Y%)
Disease or Insect Outbreak	Default Risk	3%	3%
Other Catastrophic Events	Default Risk	3%	3%

[28] When determining the appropriate risk rating for the Financial Failure Risk Category, use the higher value if intending to use PIA Subordination Clause Type I and the lower value if intending to use PIA Subordination Clause Type II. Please refer to the Project Implementation Agreement on the Reserve website for further information.

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 B 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 B.1.

To determine whether a Reforestation Project is eligible, perform the following steps:

1. Identify whether site preparation costs[29] 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 percent or more of the Project Area; or
        ii. Soil ripping has occurred on more than 50 percent 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 the most current Assessment Area Data File, available on the Forest Project Protocol webpage.
3. Identify the standard Rotation Age for the project's Assessment Area, from the lookup table in the most current Assessment Area Data File, available on the Forest Project Protocol webpage.
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 B.1.

[29] 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 B.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

CAPCOA GHG Rx Forestry Protocol #1:

Compliance Offset Protocol
U.S. Forest Projects

(Based on U.S. Forest Project protocol adopted on October 20, 2011 by the California Air Resources Board)

(Approved by the CAPCOA Board on May 1, 2013)

The following conditions apply for use in the CAPCOA GHG Rx:

1. The protocol allows projects to be located in any privately owned forest land in the United States of America. Only GHG emission reductions developed from projects within California are eligible for listing in the CAPCOA GHG Rx;

2. Projects occurring after 1/1/07 are eligible unless the reductions are associated with San Joaquin Valley APCD Rule 2301 and a project start date of 1/1/05 may apply;

3. Avoided conversion projects require establishing a conservation easement. Avoided conversion projects using this protocol for the CAPCOA GHG Rx must designate CAPCOA as a third party beneficiary instead of the California Air Resources Board.

California Environmental Protection Agency

AIR RESOURCES BOARD

Compliance Offset Protocol
U.S. Forest Projects

Adopted: October 20, 2011

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Abbreviations and Acronyms

ARB	Air Resources Board
C	Carbon
CAR	Climate Action Reserve
CH_4	Methane
CO_2	Carbon dioxide
FIA	Forest Inventory and Analysis Program of the U.S. Forest Service
GHG	Greenhouse gas
lb	Pound
IFM	Improved Forest Management
N_2O	Nitrous oxide
Regulation	Cap-and-Trade Regulation, title 17, California Code of Regulations, sections 95800 et seq.
SSR	GHG Sources, GHG Sinks, and GHG Reservoirs
USFS	United States Forest Service

1 Introduction

The Compliance Offset Protocol U.S. Forest Projects (Forest Offset Protocol) provides requirements and methods for quantifying the net climate benefits of activities that sequester carbon on forestland. The protocol provides offset project eligibility rules; methods to calculate an offset 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 GHG removal enhancements caused by an offset project are accounted for in a complete, consistent, transparent, accurate, and conservative manner and may therefore be reported as the basis for issuing ARB or registry offset credits. The protocol is built off of The Climate Action Reserve's Forest Project Protocol Version 3.2.[1]

Offset Project Operators or Authorized Project Designees must use this protocol to quantify and report GHG reductions and GHG removal enhancements. The protocol provides eligibility rules, methods to quantify GHG reductions, project-monitoring instructions, and procedures for reporting Offset Project Data Reports. Additionally, all offset projects must submit to independent verification by ARB-accredited verification bodies. Requirements for verification bodies to verify Offset Project Data Reports are provided in the Cap-and-Trade Regulation (Regulation).

AB 32 exempts quantification methodologies from the Administrative Procedure Act (APA)[2]; however those elements of the protocol are still regulatory. The exemption allows future updates to the quantification methodologies to be made through a public review and Board adoption process but without the need for rulemaking documents. Each protocol identifies sections that are considered to be quantification methodologies and exempt from APA requirements. Any changes to the non-quantification elements of the offset protocols would be considered a regulatory update subject to the full regulatory development process. Those sections that are considered to be quantification methodologies are clearly indicated in the title of the chapter or subchapter if only a portion of that chapter is considered part of the quantification methodology.

[1] Climate Action Reserve (CAR 2010) Forest Project Project Protocol Version 3.2. August 31, 2010. http://www.climateactionreserve.org/wpcontent/uploads/2009/03/Forest_Project_Protocol_Version_3.2.pdft/ (accessed September 9, 2010)

[2] Health and Safety Code section 38571.

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 Forest Offset Protocol 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.

2 Forest Project Definitions and Requirements

For the purposes of this protocol, 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”). For terms not defined in Section 11, the definitions in the Regulation apply.

2.1 Project Types

The following types of Forest Project activities are eligible:

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-years) commercial opportunities. A Reforestation Project is only eligible if it can fully satisfy the eligibility rules in the Regulation and:

1. The project involves tree planting or removal of impediments to natural reforestation, 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 in trees.
2. No rotational harvesting of reforested trees or any harvesting of pre-existing carbon in live trees occurs during the first 30 years after offset project commencement unless such harvesting is needed to prevent or reduce an imminent threat of disease. Such harvesting may only occur if the Offset Project Operator or Authorized Project Designee provides 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, or removal of impediments to natural reforestation, does not follow a commercial harvest of healthy live trees that has occurred in the Project Area within the past 10 years, or since the occurrence of a Significant Disturbance, whichever period is shorter.
4. The offset project does *not* employ broadcast fertilization.
5. The offset project does not take place on land that was part of a previously listed and verified Forest Project, unless the previous Forest Project was terminated due to an Unintentional Reversal (see Section 7) or is an early action offset project transitioning to this protocol according to the provisions of the Regulation and this protocol.
6. If the offset project was an offset project in a voluntary offset program, the offset project can demonstrate it has met all legal and contractual requirements to allow it to terminate its project relationship with the voluntary offset program and be listed using this compliance offset protocol.

Reforestation Projects on both private and public lands, excluding federal lands that are not included in the categories of land listed in section 3.6 of this protocol, are eligible.

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 it can fully satisfy the eligibility rules in the Regulation and:

1. The offset project takes place on land that has greater than 10 percent tree canopy cover.
2. The offset project employs natural forest management practices, as defined in Section 3.8.2 of this protocol.
3. The offset project does *not* employ broadcast fertilization.
4. The offset project does not take place on land that was part of a previously listed and verified Forest Project, unless the previous Forest Project was terminated due to an Unintentional Reversal (see Section 7) or is an early action offset project transitioning to this protocol according to the provisions of the Regulation and this protocol.
5. If the offset project was an offset project in a voluntary offset program, the offset project can demonstrate it has met all legal and contractual requirements to allow it to terminate its project relationship with the voluntary offset program and be listed using this compliance offset protocol.

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.
- Maintaining stocks at a high level.

Improved Forest Management Projects on both private and public lands, excluding federal lands that are not included in the categories of land listed in section 3.6 of this protocol, are eligible.

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 Qualified Conservation Easement or transfer to public ownership, excluding transfer to federal ownership. An Avoided Conversion Project is only eligible if it can fully satisfy the eligibility rules in the Regulation and:

1. It can be demonstrated 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 offset project does *not* employ broadcast fertilization.
3. The offset project does not take place on land that was part of a previously listed and verified Forest Project, unless the previous Forest Project was terminated due to an Unintentional Reversal (see Section 7) or is an early action offset project transitioning to this protocol according to the provisions of the Regulation and this protocol.
4. If the offset project was an offset project in a voluntary offset program, the offset project can demonstrate it has met all legal and contractual requirements to allow it to terminate its project relationship with the voluntary offset program and be listed using this compliance offset protocol.

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 offset project commencement.

2.2 Forest Owners

A Forest Owner is the owner of any interest in the real (as opposed to personal) property involved in a Forest Project, excluding government agency third party beneficiaries of conservation easements. Generally, a Forest Owner is the owner in fee of the real property involved in a Forest Project. In some cases, one entity may own the land while another entity may have an interest in the trees or the timber on the property, in which case all entities or individuals with interest in the real property are collectively considered Forest Owners, however, a single Forest Owner must be identified as the Offset Project Operator.

The Offset Project Operator is responsible for undertaking, listing, and verifying a Forest Project, however, all Forest Owner(s) are ultimately responsible for all Forest Project commitments. The Offset Project Operator may identify an Authorized Project Designee pursuant to §95974 of the Regulation, to assist or consult with implementation of the Forest Project. All information submitted to ARB or an Offset Project Registry shall reference the Offset Project Operator and all Forest Owner(s) who are 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 listing, and must adhere to requirements in the Regulation and requirements related to duration and crediting periods.

3.1 Additionality

ARB and registry offsets credits must be generated by projects that yield surplus GHG emission reductions or removal enhancements that exceed any GHG reductions or removals otherwise required by law or regulation, or any GHG reduction or removal that would otherwise occur in a conservative Business-As-Usual Scenario. Forest Projects must satisfy the following to be considered additional:

1. Forest Projects must achieve GHG reductions or GHG removal enhancements above and beyond any GHG reductions or GHG removal enhancements that would result from compliance with any federal, state, or local law, regulation or ordinance. Forest Projects must also achieve GHG reductions and GHG removal enhancements above and beyond any GHG reductions or GHG removal enhancements that would result from compliance with any court order or other legally binding mandates, including management plans (such as Timber Harvest Plans) that are required for government agency approval of harvest activities. Legally binding mandates also include conservation easements or deed restrictions, except where such conservation easements have been enacted in support of the Forest Project, as described in Section 3.5. This requirement is assessed through the Legal Requirement Test in 3.1.1.
2. Forest Projects must achieve GHG reductions or GHG removal enhancements above and beyond any GHG reductions or GHG removal enhancements that would result from engaging in Business-As-Usual activities, as defined by the Regulation and the requirements described and assessed through the Performance Test in Section 3.1.2.

3.1.1 Legal Requirement Test

To meet additionality requirements, the following legal requirement test must be met, specific to each type of Forest Project.

3.1.1.1 Reforestation Projects

Reforestation Project activities cannot be legally required (as defined in 3.1 above) at the time of offset project commencement. Modeling of the Forest 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

Improved Forest Management Project activities (defined as management activities intended to maintain or increase carbon stocks relative to baseline levels) cannot be legally required (as defined in 3.1 above) at the time of offset project commencement. Modeling of the Forest 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

Avoided Conversion Project activities cannot be legally required (as defined in 3.1 above) at the time of offset project commencement. Modeling of the Forest Project's baseline carbon stocks must reflect all legal constraints, as required in Section 6.3 of this protocol.

Official documentation must be submitted 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(s) 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 requirements and methods 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 GHG removal enhancements in excess of those that would have occurred under a conservative 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 a real estate appraisal for the Project Area (as defined in Section 4) is submitted 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, and the commercial viability of mineral extraction.
   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[3] and the appraiser must meet the qualification standards outlined in Internal Revenue Code, Section 170 (f)(11)(E)(ii).[4]

3.2 Offset Project Commencement

The date of offset project commencement for a Forest Project is the date on which an activity is first implemented that will lead to increased GHG reductions or GHG removal enhancements relative to the Forest Project's baseline. The following actions identify offset project commencement for each project type:

- For a Reforestation Project, the action is the planting of trees, the removal of impediments to natural regeneration, 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, or transferring the Project Area to public ownership.
- For an Avoided Conversion Project, the action is committing the Project Area to continued forest management and protection through recording a conservation

[3] Uniform Standards of Professional Appraisal Practice. http://www.uspap.org/2010USPAP/toc.htm. (Accessed October 1, 2010).
[4] Section 170 (f)(11)(E)(ii) 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."

easement with a provision to maintain the Project Area in forest cover or transferring the Project Area to public ownership.

An Improved Forest Management project's offset project commencement date must be linked to a discrete, verifiable action that delineates a change in practice relative to the Forest Project's baseline. Any one of the following actions denotes an Improved Forest Management project's offset project commencement date:

- Recordation of a conservation easement on the Project Area. The date the easement was recorded is the Forest Project's offset project commencement date.
- Transferring of property ownership (to a public or private entity). The offset project commencement date is the date of property transfer.
- Submitting the offset project listing information specified in Section 9.1.1. Offset project commencement is the date of submittal of listing information, provided that the offset project completes verification within 30 months of being submitted. If the offset project does not meet this deadline, the listing information must be resubmitted under the latest version of the protocol.

Adequate documentation denoting the offset project commencement date must include where applicable, deeds of trust, title reports, conservation easement documentation, dated forest management plans, and/or other relevant contracts or agreements.

3.3 Project Crediting Period

The crediting period for offset projects using this protocol is 25 years. This means that after a successful initial verification, a Forest Project will be eligible to receive Offset Credits for GHG reductions and/or removals quantified using this protocol, and verified by ARB-approved verification bodies, for a period of 25 years following the offset project's commencement date. A project may be renewed for subsequent crediting periods, subject to approval at that time and use of the quantification methods in the most recent approved version of the Forest Offset Protocol at the time of renewal.

The baseline for any Forest Project under this version of the Forest Offset Protocol is valid for the duration of the Project Life following a successful initial verification where the offset project receives a Positive Verification Statement.

3.4 Project Life and Minimum Time Commitment

Project Life is defined as the period of time between offset project commencement and a period of 100 years following the issuance of any ARB or registry offset credit for GHG reductions or GHG removal enhancements achieved by the offset project. Forest Projects must continue to monitor, verify and report offset project data for a period of 100 years following any ARB or registry offset credit issuance. For example, if ARB or registry offset credits are issued to a Forest Project in year 25 following offset project commencement, monitoring and verification activities must be maintained until year 125.

There are three possible exceptions to this minimum time commitment:

1. A Forest Project automatically terminates if a Significant Disturbance occurs leading to an Unintentional Reversal that reduces the Forest Project's Standing Live Carbon Stocks below the Forest Project's baseline Standing Live Carbon Stocks. If this occurs, the requirements of section 95983(d) of the Regulation shall apply.

2. A Forest Project automatically terminates if Project Lands or timber rights are sold to an entity that does not elect to take over the Forest Project responsibilities and commitments. Such a termination will require a quantity of ARB Offset Credits to be retired, as specified under ‘Retiring Compliance Instruments Following Project Termination,’ below.
3. A Forest Project may be voluntarily terminated prior to the end of its minimum time commitment if the required quantities of Compliance Instruments are retired, as specified under ‘Retiring Compliance Instruments Following Project Termination,’ below.

Retiring Compliance Instruments Following Project Termination

If a Forest Project is terminated for any reason except an unintentional reversal, the Forest Owner must replace any ARB Offset Credits that have previously been issued based on the requirements in the Regulation and the following provisions:

a. For a Reforestation or Avoided Conversion Project, a quantity of Compliance Instruments equal to the total number of ARB Offset Credits issued, and where applicable, all Early Action Offset Credits issued pursuant to section 95990(i) of the Regulation, to the project over the preceding 100 years must be retired.
b. For an Improved Forest Management Project, a quantity of Compliance Instruments equal to the total number of ARB Offset Credits issued, and where applicable, all Early Action Offset Credits issued pursuant to section 95990(i) of the Regulation, to the project over the preceding 100 years, multiplied by the appropriate compensation rate indicated in Table 3.1 must be retired.

Table 3.1. Compensation Rate for Terminated Improved Forest Management Projects

Number of years that have elapsed between offset project commencement and the date of termination	Compensation Rate
0-5	1.40
6-10	1.20
11-20	1.15
21-25	1.10
31-50	1.05
>50	1.00

3.5 Use of Qualified Conservation Easements

For Avoided Conversion Projects on private land, the Forest Owner must record a Qualified Conservation Easement against the offset project’s property in order for the Forest Project to be eligible. Any Forest Project that records a Qualified Conservation Easement may reduce its risk rating and required contribution to the Forest Buffer Account in Appendix D. To be “qualified” for purposes of ARB’s compliance offset program, the conservation easement must:

a. Be granted by the owner of the fee to a qualified holder of a conservation easement in accordance with the conservation easement enabling statute of the state in which the project is located;
b. Be perpetual in duration;

c. Expressly acknowledge that ARB is a third party beneficiary of the conservation easement with the right to enforce all obligations under the easement and all other rights and remedies conveyed to the holder of the easement. These rights include standing as an interested party in any proceeding affecting the easement.

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

As indicated in Section 3.2, an offset project commencement date must be linked to a discrete, verifiable action. The recordation of a conservation easement may be used to denote the commencement date of pre-existing projects between December 31, 2006 and December 31, 2010. Any previously recorded conservation easement may only be considered a Qualified Conservation Easement if it was recorded within one year prior to the identified project commencement date. Any previously recorded conservation easement must still meet, or be modified to meet, all of the requirements of this section (i.e. expressly acknowledging ARB as a third-party beneficiary) in order to be considered "qualified."

The conservation easement may be amended to exclude ARB as a third party beneficiary upon termination of the Forest Project or once all legal requirements for monitoring and verification of carbon stocks under this Compliance Offset Protocol have been met.

3.6 Project Location

All Forest Projects must be located in the United States of America. 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 Forest 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. Offset projects on federal lands that are not included in the categories of land in the following paragraph are not eligible at this time.

Forest Projects situated on the following categories of land are only eligible under this protocol if they meet the requirements of this protocol and the Regulation, including the waiver of sovereign immunity requirements of section 95975(l) in the Regulation:

1. Land that is owned by, or subject to an ownership or possessory interest of a Tribe;
2. Land that is "Indian lands" of a Tribe, as defined by 25 U.S.C. §81(a)(1); or
3. Land that is owned by any person, entity, or Tribe, within the external borders of such Indian lands.

The Forest Offset Protocol contains data tables, equations, and benchmark data applicable to projects located in the United States. 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. Forest Projects in Alaska and Hawaii are not eligible at this time due to lack of region-specific data.

3.7 Regulatory Compliance

As stated in the Regulation, Project Lands must fulfill all applicable local, regional and national requirements on environment impact assessments that apply based on the offset project location. Offset projects must also meet any other local, regional, and national requirements that might apply.

Each time the Forest Project is verified, the Offset Project Operator or Authorized Project Designee must attest that the Forest Owner and Project Lands are in compliance with all applicable laws and regulations. The Offset Project Operator or Authorized Project Designee are required to disclose in writing to the verifier any and all instances of non-compliance associated with the Project Lands with any legal requirement. If a verifier finds that an offset project is in a state of non-compliance with any environmental law or regulation, then ARB or registry offset credits will not be issued for GHG reductions or GHG removal enhancements that occurred during any reporting period of non-compliance.

3.8 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 offset projects to employ both sustainable long-term harvesting practices and Natural Forest Management practices over time, as described below. Any non-conformance with the sustainable harvesting and Natural Forest Management requirements in this section will result in an adverse offset verification statement during the reporting periods that the Forest Project was out of conformance.

3.8.1 Sustainable Harvesting Practices

At the time commercial harvesting is either planned or initiated within the Project Area, the Offset Project Operator or Authorized Project Designee must demonstrate that the Forest Owner(s) employs and demonstrates 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 the Forest Stewardship Council, Sustainable Forestry Initiative, or Tree Farm System certification programs. Regardless of the program, the terms of certification must require adherence to and verification of harvest levels which can be permanently sustained over time.
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.
3. The Forest Owner must employ uneven-aged silvicultural practices (if harvesting occurs) and must maintain canopy cover averaging at least 40 percent across the entire forestland owned by the Forest Owner in the same Assessment Areas covered by the Project Area, as measured on any 20 acres within the Forest Owner’s landholdings found in any of these Assessment Areas, 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.

3.8.2 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 within the Project Area and 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.

The Forest Offset Protocol Resources section of ARB's webpage provides required references by Assessment Area for the definition of native forests (see Appendix F). If a state/regional reference is unavailable or inadequate, documentation from a state botanist or other qualified independent resource, recognized as expert by academic, private and government organizations, must be submitted indicating that the project promotes and maintains 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. A written statement must be submitted from the government agency in charge of forestry regulation in the state where the project is located stipulating that the planting of native trees outside their current range is appropriate as an adaptation to climate change.

The following 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 3.8.3.
2. Forest Projects must show verified progress (verified at scheduled site-visits) 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, as specified in Table 3.2 and Section 3.8.4 below.

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 (i.e. for the duration of the Project Life). 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 still eligible.

The evaluation criteria 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 carbon 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 initial 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 verification site visits must demonstrate continuous progress toward goal. This criterion must be met within 25 years.	Project is not in conformance with protocol requirements.	
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 'Species Diversity Index' (incorporated by reference, October 10, 2010) in the Forest Offset Protocol Resources section of ARB's website. Where the Project Area does not naturally consist of a mixed species distribution, a written statement from the government agency in charge of forestry regulation in the state where the project is located stipulating that the project area does not naturally consist of a mixed species distribution must be submitted.	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. In these cases, a written statement from the government agency in charge of forestry regulation in the state where the project is located must be submitted as described under "Criteria"
Reforestation To the extent seed is available, and/or physical site characteristics permit, Reforestation Projects that involve planting of seedlings 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 'Species Diversity Index' (incorporated by reference, October 10, 2010) in the Assessment Area table in the Forest Offset Protocol Resources section of ARB's website. Where seed is unavailable, the Reforestation Project is based on natural regeneration, or physical site characteristics are limiting, a written statement from the government agency in charge of forestry regulation in the state where the project is located stipulating that seed is unavailable, the Reforestation Project is based on natural regeneration, or physical site characteristics are limiting must be submitted.	Species composition is assessed at initial verification from inventory data. Project must show continuous progress toward criteria. These criteria must be met within 25 years.	Project is not in conformance with protocol requirements.	
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, whose certification standards require adherence to and verification of harvest levels which can be permanently sustained	Condition shall be met at all times during project and is assessed during each verification.	Project is not in conformance with protocol requirements.	Applies to all project types at first regeneration harvest

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.)			
On a watershed scale up to 10,000 acres (or the project area, whichever is smaller), 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 excluded from this test.)	Age classes (if even age management is used) are assessed at project initiation and each verification site visit.	NA	
	Project must show continuous progress toward criteria. This criterion must be met within 25 years.	Project is not in conformance with protocol requirements.	
Structural Elements (Standing and Lying Dead Wood)			
Lying dead wood must be retained in sufficient quantities, as described below. **For portions of the Project Area that have not recently undergone salvage harvesting:** If a verifier determines that the quantity of lying dead wood is commensurate with recruitment from standing dead trees (i.e. there is no evidence that lying dead wood has been actively removed), the project must maintain (or demonstrate ongoing progress toward) an average of at least: ▪ one (1) metric ton of carbon (C) per acre; or ▪ 1% of standing live carbon stocks, in *standing* dead wood, whichever is higher, If a verifier determines that the quantity of lying dead wood is **not** commensurate with recruitment from standing dead trees (i.e. it appears lying dead wood has been actively removed), the project must maintain (or demonstrate ongoing progress toward) an average of at least: ▪ two (2) metric tons of carbon (C) per acre; or ▪ 1% of standing live carbon stocks, in *standing* dead wood, whichever is higher, Standing dead wood may be evenly or unevenly distributed throughout the portion of the Project Area unaffected by salvage harvesting, as long as the appropriate minimum average tonnage per acre requirement is met. **For portions of the Project Area that have undergone salvage harvesting within the previous year:*** If a verifier determines that the quantity of lying dead wood following salvage harvest is commensurate with recruitment from standing dead trees, the project must maintain (or demonstrate	Assessed during project at each verification audit.	Project is not in conformance with protocol requirements.	Applies to all project types throughout the project life

ongoing progress toward) an average of at least two (2) metric tons of carbon (C) per acre in *standing* dead wood, If a verifier determines that the quantity of lying dead wood following harvest is **not** commensurate with recruitment from standing dead trees, the project must maintain (or demonstrate ongoing progress toward) an average of at least four (4) metric tons of carbon (C) per acre in *standing* dead wood, Standing dead wood may be evenly or unevenly distributed throughout the portion of the Project Area subject to salvage harvesting, as long as the appropriate minimum average tonnage per acre requirement is met. This requirement must be met for a period of 30 years following the salvage harvest. After 30 years, the portion of the Project Area subject to salvage harvesting must meet the requirements for portions that have not recently undergone salvage harvesting (described above).			

3.8.3 Promotion of the Onsite Standing Live Carbon Stocks

In an effort to promote and maintain the environmental benefits of Forest Projects, the standing live carbon stocks within the Project Area must be maintained and/or increased during the Project Life. Therefore, except as specified below, ARB or registry offset credits will not be issued for quantified GHG reductions and GHG removal enhancements achieved by a Forest Project if a Forest Project's Offset Project Data Reports – over any 10-year consecutive period – indicate a decrease in the standing live carbon stocks.

Exceptions 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 carbon stocks; where reductions are due to non-harvest disturbances; or where reductions are required by law. Note that these exceptions in no way change or affect the 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 are not in conformance with protocol requirements, except 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 actions that will be taken to reduce the risks must be documented. 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 management plan that demonstrates harvest levels can be permanently sustained over time and that is sanctioned and monitored by a state or federal agency. In this case, documentation must be submitted at the time of the Forest Project's Listing, indicating that a balancing of age classes, resulting in a decrease in the standing live carbon stocks, is planned at the initiation of the Forest Project (Figure 3.1). At no time over the Project Life shall the Forest Project's inventory of standing live carbon stocks fall below the Forest Project's baseline 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. Over any consecutive 10-year period, average standing live carbon stocks must be maintained at or above the standing live carbon stocks at the initiation of the project.

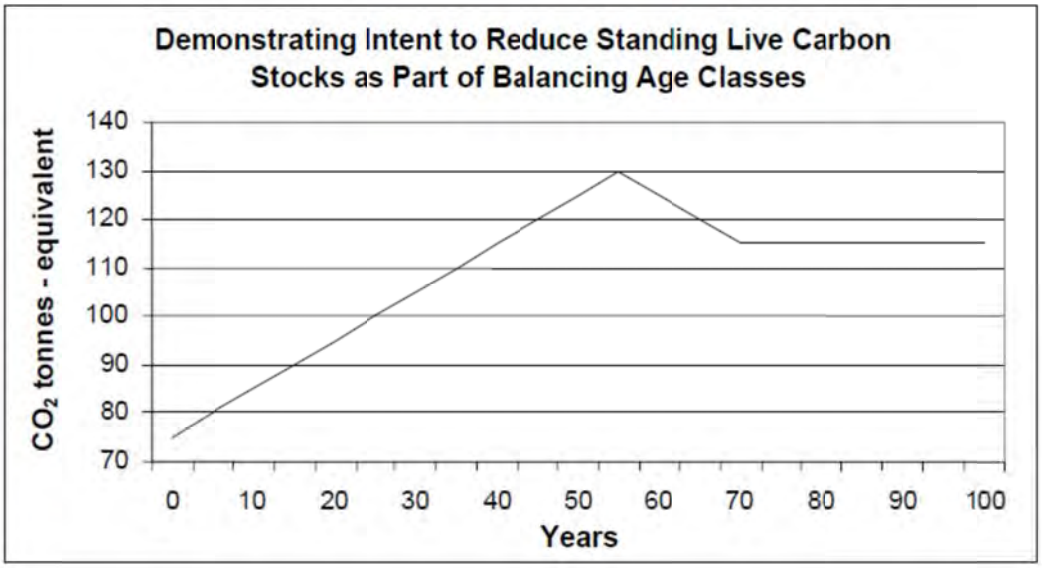


Figure 3.1. Example of Reducing Standing Live Carbon Stocks as Part of Balancing Age Classes

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 during the Project Life shall the Forest Project's inventory of standing live carbon stocks fall below the Forest Project's baseline 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. Over any consecutive 10-year period, average standing live carbon stocks must be maintained at or above the standing live carbon stocks at the initiation of the project. Documentation submitted at the time the Forest Project is Listed must indicate that fluctuations in the Forest Project's standing live carbon stocks are an anticipated silvicultural activity and that the overall trend will be for standing live carbon stocks to increase or stay the same over the life of the offset project (Figure 3.2).

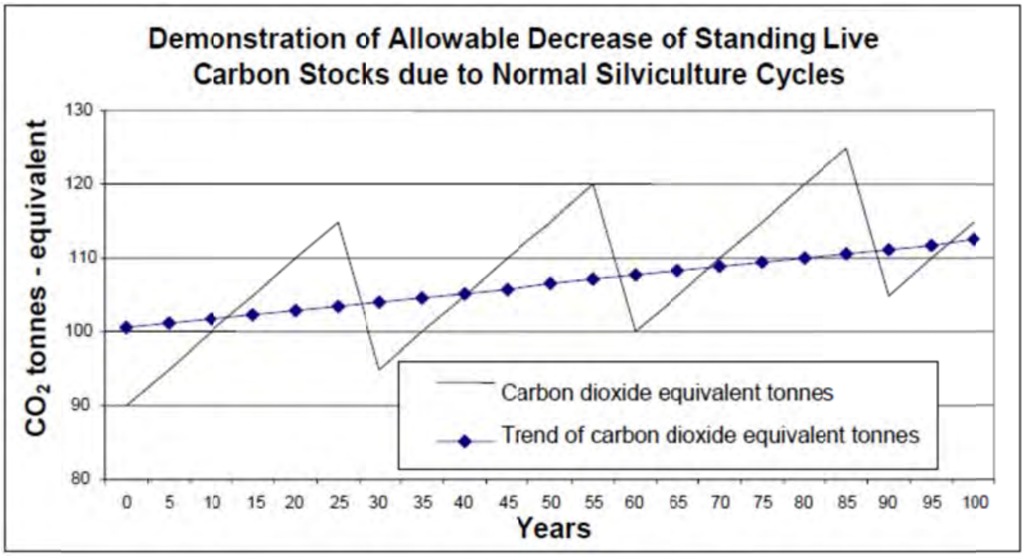


Figure 3.2. Example of Allowable Decrease of Standing Live Carbon Stocks due to Normal Silviculture Cycles

4. The decrease is due to an unintentional reversal such as wildfire, disease, flooding, wind-throw, insect infestation, or landslides.
5. The decrease in standing live carbon stocks occurs after the final crediting period (during the required 100 year monitoring period) as long as the residual live carbon stocks are maintained at a level that assures all credited standing live carbon stocks are permanently maintained.

3.8.4 Balancing Age and Habitat Classes

A variety of silvicultural practices may be employed in the Project Area during the course of a Forest Project though the protocol does not endorse any particular practice. To ensure environmental integrity, Forest Projects must meet a minimum set of standards in the use of any such practices.

For offset projects that employ even-aged management practices, harvesting must be limited to stands no greater than 40 acres. Stands adjacent to recently harvested stands must not be harvested using an even-aged harvest until the average age of the adjacent stand is at least 5-years old, or the average height in the adjacent stand is at least 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 20 years after reforestation of such areas.

The protocol does not override a landowner's obligation to abide by applicable laws and regulations, including any governing forest practice rules that may be more stringent. Regardless of the silvicultural practice employed, landowners must fulfill their commitment under the protocol to permanently maintain or increase onsite standing live carbon stocks (i.e. the carbon in live trees within the Project Area) as specified in Section 3.8.3.

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. The boundaries must be defined using a map, or maps, that display public and private roads, major watercourses (4th order or greater), topography, towns, and either public land survey townships, ranges, and sections or latitude and longitude. The maps must be of adequate resolution to clearly identify the required features. The Project Area can be contiguous or separated into tracts. The Project Area may also extend across multiple Assessment Areas within an Ecosection or Supersection (see Appendix F) and across no more than two adjacent Ecosections or Supersections.

For Improved Forest Management Projects, the geographic boundaries may be defined such that non-forested areas, or areas not under forest management, are excluded from the Project Area.

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 percent of the carbon stocks being emitted. A Reforestation Project may defer finalizing the boundaries of the Project Area until the second full verification provided: (1) all lands included in the Project Area were initially included in the Project Area during listing, and (2) the Reforestation Project has elected to defer its initial inventory until the second full verification. This allows Reforestation Projects to initially identify a larger Project Area during project listing that may be revised prior to the completion of the forest inventory and the issuance of any ARB or registry offset credits.

For Avoided Conversion Projects, the Project Area is defined through the required appraisal process. The Project Area must be determined following the boundary definitions in Table 4.1 based on the type of anticipated conversion. All lands in the Project Area must be covered by the Qualified Conservation Easement or transferred to public ownership as part of the program.

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 having a ‘higher and better use’ in residential development.
Agricultural Conversion or Mining	The boundary of the parcel or parcels that have been appraised as having a ‘higher and better use’ in agricultural production or mining.
Golf Course	The boundary of the parcel or parcels that have been appraised as having a ‘higher and better use’ as a golf course. This is to include forested areas within 200’ of fairways, greens, and buildings.
Commercial Buildings	The boundary of the parcel or parcels that have been appraised as having a ‘higher and better use’ in commercial buildings. This is to include forested areas with 200’ of suitable building sites.

5 Offset Project Boundary

The Offset Project Boundary defines all the GHG emission sources, GHG sinks, and GHG reservoirs (SSR's) that must be accounted for in quantifying a Forest Project's GHG reductions and GHG removal enhancements (Section 6). The Offset Project Boundary encompasses all the GHG emission SSR's that may be significantly affected by Forest Project activities, such as forest carbon stocks and harvested wood products. For accounting purposes, the GHG sources, GHG sinks, and GHG reservoirs included in the Offset Project Boundary are organized according to whether they are predominantly associated with a Forest Project's "Primary Effect" (i.e. the Forest Project's intended changes in carbon stocks, GHG emissions, or GHG removal enhancements) or its "Secondary Effects" (i.e. unintended changes in carbon stocks, GHG emissions, or GHG removal enhancements caused by the Forest Project). Secondary effects may include increases in mobile combustion CO_2 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 (referred to as "Leakage"). Offset projects are required to account for Secondary Effects following the methods described in Section 6.

The following tables provide a comprehensive list of the SSRs that may be affected by a Forest Project, and indicate which SSRs must be included in the Offset Project Boundary for each type of Forest Project. If a SSR is designated as a "reservoir/pool," this means that GHG reductions and GHG removal enhancements are accounted for by quantifying changes in carbon stock levels. For SSRs designated as GHG sources or GHG sinks, GHG reductions and GHG removal enhancements are accounted for by quantifying changes in GHG emission or GHG removal enhancement rates, as described in the tables.

5.1 Reforestation Projects

Table 5.1. Offset Project Boundary – Reforestation Projects

SSR	Description	Type	Gas	Included or Excluded?	Quantification Method
Primary Effect Sources, Sinks, and Reservoirs					
RF-1	Standing live carbon (carbon in all portions of living trees)	Reservoir / Pool	CO_2	Included	**Baseline:** Modeled based on initial field inventory measurements **Project:** Measured by field measurements and updating forest carbon inventory
RF-2	Shrubs and herbaceous understory carbon	Reservoir / Pool	CO_2	Included	**Baseline:** Modeled based on initial field inventory measurements **Project:** Measured by updating forest carbon inventory
RF-3	Standing dead carbon (carbon in all portions of dead, standing trees)	Reservoir / Pool	CO_2	Included	**Baseline:** Modeled based on initial field inventory measurements **Project:** Measured by updating forest carbon inventory
RF-4	Lying dead wood carbon	Reservoir / Pool	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
RF-5	Litter and duff carbon (carbon in	Reservoir / Pool	CO_2	Excluded	**Baseline:** N/A

SSR	Description	Type	Gas	Included or Excluded?	Quantification Method
	dead plant material)				**Project:** N/A
RF-6	Soil carbon	Reservoir / Pool	CO_2	*Included/excluded: Soil carbon must be included in the Offset Project Boundary if any of the following occur: ▪ Site preparation activities involve deep ripping, furrowing, or plowing where soil disturbance exceeds (or is expected to exceed from the baseline characterization and modeling) 25 percent of the Project Area over the Project Life, or ▪ Mechanical site preparation activities are not conducted on contours.	**Baseline:** Modeled based on initial field inventory measurements **Project:** Measured by updating forest carbon inventory
RF-7	Carbon in in-use forest products	Reservoir / Pool	CO_2	Included	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes
RF-8	Forest product carbon in landfills	Reservoir / Pool	CO_2	Excluded when project harvesting exceeds baseline Included when project harvesting is below baseline	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes
Secondary Effect Sources, Sinks, and Reservoirs					
RF-9	Biological emissions from site preparation activities	Source	CO_2	*Included: Biological emissions from site preparation are not quantified separately, but rather are captured by measuring changes in included carbon reservoirs	**Baseline:** N/A **Project:** Quantified based on measured carbon stock changes in included reservoirs (SSRs #RF-2 and #RF-6)
RF-10	Mobile combustion emissions from site preparation activities	Source	CO_2	Included	**Baseline:** N/A **Project:** Estimated using default emission factors
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
RF-11	Mobile combustion emissions from ongoing project operation & maintenance	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
RF-12	Stationary combustion emissions from	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A

SSR	Description	Type	Gas	Included or Excluded?	Quantification Method
	ongoing project operation & maintenance				
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
RF-13	Biological emissions from clearing of forestland outside the Project Area	Source	CO_2	Included	**Baseline:** N/A **Project:** Estimated using default land-use conversion factors for non-project land
RF-14	Biological emissions/ removals from changes in harvesting on forestland outside the Project Area	Source / Sink	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
RF-15	Combustion emissions from production, transportation, and disposal of forest products	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A -
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
RF-16	Combustion emissions from production, transportation, and disposal of alternative materials to forest products	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
RF-17	Biological emissions from decomposition of forest products	Source	CO_2	Included	**Baseline:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR #RF-7) and landfills (SSR #RF-8) **Project:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR #RF-7) and landfills (SSR #RF-8)
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A

5.2 Improved Forest Management Projects

Table 5.2. Offset Project Boundary – Improved Forest Management Projects

SSR	Description	Type*	Gas	Included or Excluded?	Quantification Method
Primary Effect Sources, Sinks, and Reservoirs					
IFM-1	Standing live carbon (carbon in all portions of living trees)	Reservoir / Pool	CO_2	Included	**Baseline:** Modeled based on initial field inventory measurements **Project:** Measured by field measurements and updating forest carbon inventory
IFM-2	Shrubs and herbaceous understory carbon	Reservoir / Pool	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
IFM-3	Standing dead carbon (carbon in all portions of dead, standing trees)	Reservoir / Pool	CO_2	Included	**Baseline:** Modeled based on initial field inventory measurements **Project:** Measured by updating forest carbon inventory
IFM-4	Lying dead wood carbon	Reservoir / Pool	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
IFM-5	Litter and duff carbon (carbon in dead plant material)	Reservoir / Pool	CO_2	Excluded	**Baseline:** Modeled based on initial field inventory measurements **Project:** Measured by updating forest carbon inventory
IFM-6	Soil carbon	Reservoir / Pool	CO_2	*Included/ Excluded Soil carbon must be included in the Offset Project Boundary, if any of the following activities occur: ▪ Site preparation activities involve deep ripping, furrowing, or plowing where soil disturbance exceeds (or is expected to exceed from the baseline characterization and modeling) 25 percent of the Project Area over the Project Life, or ▪ Mechanical site preparation activities are not conducted on contours.	**Baseline:** Modeled based on initial field inventory measurements **Project:** Measured by updating forest carbon inventory
IFM-7	Carbon in in-use forest products	Reservoir / Pool	CO_2	Included	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes
IFM-8	Forest product carbon in landfills	Reservoir / Pool	CO_2	Excluded when project harvesting exceeds baseline Included when project harvesting is below baseline	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes
Secondary Effect Sources, Sinks, and Reservoirs					
IFM-9	Biological	Source	CO_2	*Included	**Baseline:** N/A

SSR	Description	Type*	Gas	Included or Excluded?	Quantification Method
	emissions from site preparation activities			Biological emissions from site preparation are not quantified separately, but rather are captured by measuring changes in included carbon reservoirs	**Project:** Quantified based on measured carbon stock changes in included reservoirs (SSR #IFM-6, where applicable)
IFM-10	Mobile combustion emissions from site preparation activities	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
IFM-11	Mobile combustion emissions from ongoing project operation & maintenance	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A .
IFM-12	Stationary combustion emissions from ongoing project operation & maintenance	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
IFM-13	Biological emissions from clearing of forestland outside the Project Area	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
IFM-14	Biological emissions/ removals from changes in harvesting on forestland outside the Project Area	Source / Sink	CO_2	Included / Excluded	**Baseline:** N/A **Project:** Estimated using a default 20% “leakage” factor applied to the difference in harvest volume relative to baseline
IFM-15	Combustion emissions from production, transportation, and disposal of forest products	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A

SSR	Description	Type*	Gas	Included or Excluded?	Quantification Method
IFM-16	Combustion emissions from production, transportation, and disposal of alternative materials to forest products	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
IFM-17	Biological emissions from decomposition of forest products	Source	CO_2	*Included	**Baseline:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR #IFM-7) and landfills (SSR #IFM-8) **Project:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR #IFM-7) and landfills (SSR #IFM-8)
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A

5.3 Avoided Conversion Projects

Table 5.3. Offset Project Boundary – Avoided Conversion Projects

SSR	Description	Type*	Gas	Included or Excluded?	Quantification Method
Primary Effect Sources, Sinks, and Reservoirs					
AC-1	Standing live carbon (carbon in all portions of living trees)	Reservoir / Pool	CO_2	Included	**Baseline:** Modeled based on initial field inventory measurements and expected land-use conversion rates **Project:** Measured by field measurements and updating forest carbon inventory
AC-2	Shrubs and herbaceous understory carbon	Reservoir / Pool	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
AC-3	Standing dead carbon (carbon in all portions of dead, standing trees)	Reservoir / Pool	CO_2	Included	**Baseline:** Modeled based on initial field inventory measurements and expected land-use conversion rates **Project:** Measured by updating forest carbon inventory
AC-4	Lying dead wood carbon	Reservoir / Pool	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
AC-5	Litter and duff carbon (carbon	Reservoir / Pool	CO_2	Excluded	**Baseline:** N/A

SSR	Description	Type*	Gas	Included or Excluded?	Quantification Method
	in dead plant material)				**Project:** N/A
AC-6	Soil carbon	Reservoir / Pool	CO_2	*Included/ Excluded Soil carbon must be included in the Offset Project Boundary, if any of the following activities occur: ▪ Site preparation activities involve deep ripping, furrowing, or plowing where soil disturbance exceeds (or is expected to exceed from the baseline characterization and modeling) 25 percent of the Project Area over the Project Life, or ▪ Mechanical site preparation activities are not conducted on contours	**Baseline:** Modeled based on initial field inventory measurements and expected land-use conversion rates **Project:** Measured by updating forest carbon inventory
AC-7	Carbon in in-use forest products	Reservoir / Pool	CO_2	Included	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes
AC-8	Forest product carbon in landfills	Reservoir / Pool	CO_2	Excluded when project harvesting exceeds baseline Included when project harvesting is below baseline	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes
Secondary Effect Sources, Sinks, and Reservoirs					
AC-9	Biological emissions from site preparation activities	Source	CO_2	*Included Biological emissions from site preparation are not quantified separately, but rather are captured by measuring changes in included carbon reservoirs	**Baseline:** N/A **Project:** Quantified based on measured carbon stock changes in included reservoirs (SSR #AC-6, where applicable)
AC-10	Mobile combustion emissions from site preparation activities	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
AC-11	Mobile combustion emissions from ongoing project operation & maintenance	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
AC-12	Stationary combustion	Source	CO_2	Excluded	**Baseline:** N/A

SSR	Description	Type*	Gas	Included or Excluded?	Quantification Method
	emissions from ongoing project operation & maintenance				**Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
AC-13	Biological emissions from clearing of forestland outside the Project Area	Source	CO_2	Included	**Baseline:** N/A **Project:** Estimated using default forestland conversion factors
AC-14	Biological emissions/ removals from changes in harvesting on forestland outside the Project Area	Source / Sink	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
AC-15	Combustion emissions from production, transportation, and disposal of forest products	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
AC-16	Combustion emissions from production, transportation, and disposal of alternative materials to forest products	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
AC-17	Biological emissions from decomposition of forest products	Source	CO_2	Included	**Baseline:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR #AC-7) and landfills (SSR #AC-8) **Project:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR #AC-7) and landfills (SSR #AC-8)
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A Decomposition of forest is not expected to be a significant source of N_2O emissions.

6 Quantifying Net GHG Reductions and GHG Removal Enhancements

This section provides requirements and methods for quantifying a Forest Project's net GHG reductions and GHG removal enhancements.

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

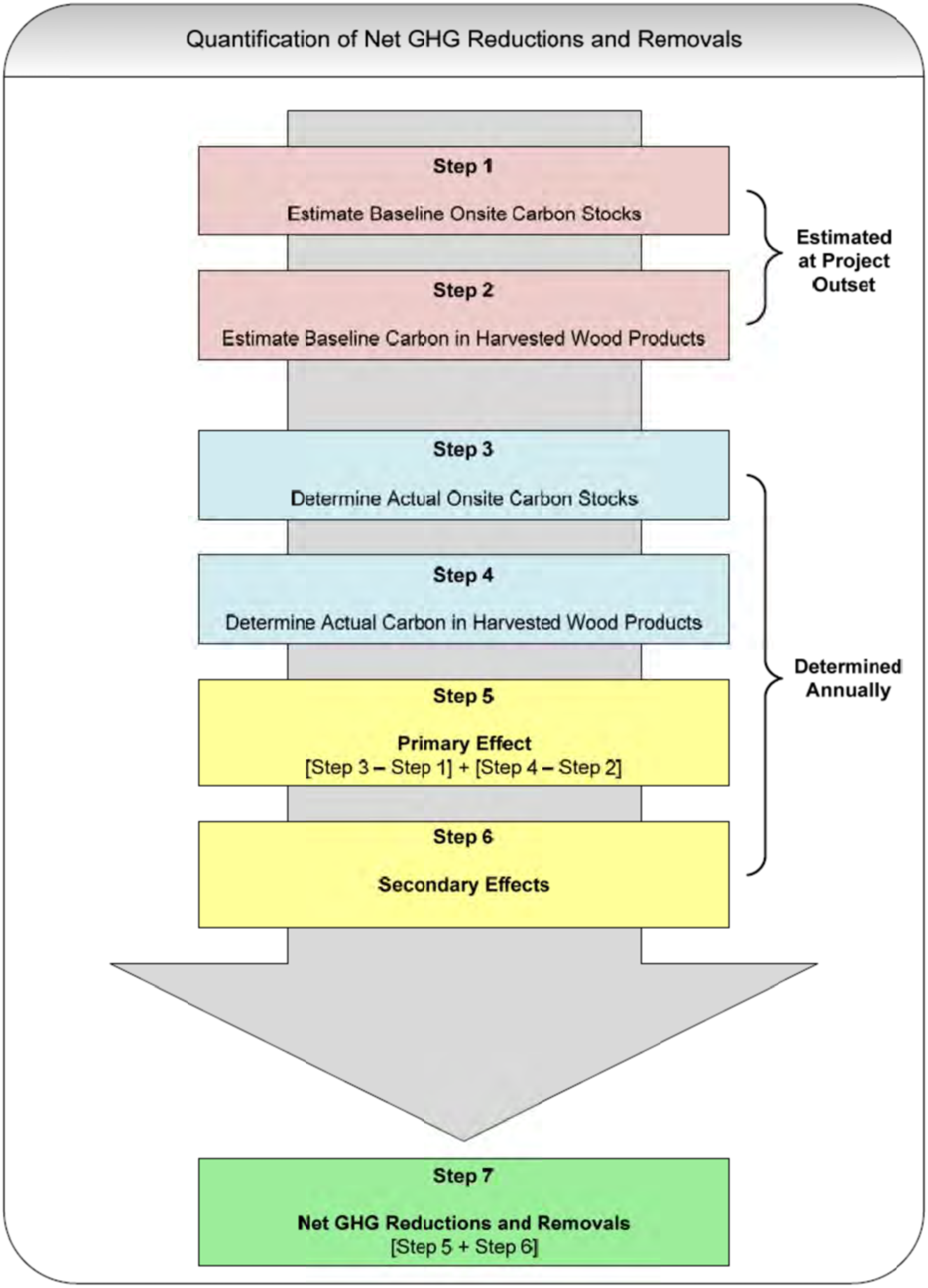
1. **Estimating baseline onsite carbon stocks.** The baseline is an estimate of what would have occurred in the absence of a Forest Project. To establish baseline onsite carbon stocks, the carbon stock changes in each of the Forest Project's required onsite carbon pools (identified in Sections 5.1 to 5.3) must be modeled over 100 years. Modeling must be based on inventoried carbon stocks at the time of the Forest Project's offset project commencement (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 requirements and methods in Appendix B. Baseline onsite carbon stocks are estimated over 100 years at the time of the Forest Project's commencement.
2. **Estimating baseline carbon in harvested wood products.** In conjunction with modeling baseline onsite carbon stocks, a forecast of any harvesting that would have occurred in the baseline must be developed and converted to an average annual harvesting volume. From this, the amount of carbon that would have been transferred each year (on average) to long-term storage in wood products can be determined. Baseline harvesting is forecasted following the requirements in this section and carbon stored in wood products must be calculated following the requirements and methods in Appendix C.
3. **Determining actual onsite carbon stocks.** Each year, the Forest Project's actual onsite carbon stocks must be determined. This must be done by updating the Forest Project's forest carbon inventory for the current year, following the requirements and methods in this section and in Appendices A and 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, any harvesting in the Project Area must be reported and from this, the amount of carbon transferred to long-term storage in wood products must be calculated following the requirements and methods in Appendix C.
5. **Calculating the offset project's Primary Effect.** Each year, the actual change in GHG emissions or GHG removal enhancements associated with the Forest Project's intended ("Primary") effect must be quantified, as defined in Section 5. For any given year, the Primary Effect is calculated by:
    a. Taking the difference between actual onsite carbon stocks for the current year and actual onsite carbon stocks for the prior year
    b. Subtracting from (a) the difference between baseline onsite carbon stocks for the current year 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 offset project's Secondary Effects.** Each year, the actual change in GHG emissions or GHG removal enhancements associated with the Forest Project's unintended ("Secondary") effects must be quantified as defined in Section 5.

Requirements and methods 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 offset project).

7. **Calculating total net GHG reductions and GHG removal enhancements.** For each year, total net GHG reductions and GHG removal enhancements 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 GHG removal enhancements in the current year. If the result is negative, this indicates a reversal has occurred except as specified below (see Section 7).

Requirements for how to perform quantification steps 1 to 4 for each Forest Project type are presented in the remainder of this section. The required formula for quantifying annual net GHG reductions and GHG removal enhancements is presented in Equation 6.1. Net GHG reductions and GHG removal enhancements must be quantified and reported in units of carbon dioxide-equivalent (CO_2e) metric tons.

A reversal occurs only if: (1) total net GHG reductions and GHG removal enhancements for the year are negative; and (2) ARB or registry offset credits have previously been issued to the Forest Project. If calculated GHG reductions and GHG removal enhancements are negative and no ARB or registry offset credits have been issued to the project since its commencement date then the result should be treated as a "negative carryover" to GHG reduction calculations in subsequent years (variable N_{y-1} in Equation 6.1). This may happen, for example, because the confidence deduction applied to actual onsite carbon stocks can result in actual values being less than baseline values in a Forest Project's initial years.


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]

Quantification Methodology

Equation 6.1.

$$QR_y = [(\Delta\ AC_{onsite} - \Delta\ BC_{onsite}) + (AC_{wp,\ y} - BC_{wp,\ y}) * 80\% + SE_y] * (1 - ACD) + N_{y-1}$$

Where,

QR_y	=	Quantified GHG reductions and GHG removal enhancements for year y
$\Delta\ AC_{onsite}$	=	$(AC_{onsite,\ y})(1 - CD_y) - (AC_{onsite,\ y-1})(1 - CD_{y-1})$ *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 (if y is the first year of the offset project, then the value for $AC_{onsite,\ y-1}$ will be zero) 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.
$\Delta\ BC_{onsite}$	=	$BC_{onsite,\ y} - BC_{onsite,\ y-1}$ *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 (if y is the first year of the offset project, then the value for $BC_{onsite,\ y-1}$ will be zero) [5]
$AC_{wp,\ y}$	=	Actual carbon in wood products produced in year y that is projected to remain stored for at least 100 years (i.e. $WP_{total,\ y}$ derived for actual harvest volumes following the requirements and methods in Appendix C)
$BC_{wp,y}$	=	Averaged annual baseline carbon in wood products that would have remained stored for at least 100 years (i.e. $WP_{total,\ y}$ derived for baseline harvest volumes following the requirements and methods 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 (occurs when total quantified GHG reductions are negative prior to the issuance of any CRTs for the project)

Note: The net change in carbon in harvested wood products, $(AC_{wp,\ y} - BC_{wp,\ y})$, is multiplied by 80 percent in Equation 6.1 to reflect market responses to changes in wood product production. The general assumption in this protocol is that for every ton of reduced harvesting caused by a

[5] For Improved Forest Management projects, where baseline onsite carbon stocks are averaged across all years, the value for $\Delta\ BC_{onsite}$ will be zero in all years except the first year of the project.

Forest Project, the market will compensate with an increase in harvesting of 0.2 tons on other lands (see Section 6.2.6).

6.1 Reforestation Projects

6.1.1 Estimating Baseline Onsite Carbon Stocks

Quantification Methodology

To estimate baseline carbon stocks for a Reforestation Project:

1. Provide a qualitative characterization of the likely vegetative conditions and activities that would have occurred without 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. 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 Forest Project's required carbon pools, following the requirements in Appendix A of this protocol.[6] For carbon pools that will be affected by site preparation, the inventory must be conducted prior to any site preparation activities. For those carbon pools that are affected by site preparation, provide an estimate of initial carbon stocks using one of the following alternatives:
    - Measuring carbon stocks using 20 sample plots located in the portion of the Project Area containing the greatest amount of biomass in the pool that will be affected.
    - Stratifying (classifying) the Project Area into similar densities and measuring stocks within the affected carbon pools using 20 sample plots per density class.
    - Measuring the affected carbon stocks based on a grid system across the Project Area.

For other carbon stocks, the inventory may be deferred, as described below.

3. Once a full inventory is obtained, perform a computer simulation that models the carbon stocks for 100 years following the forest project's commencement date, based on the qualitative characterization of what would have occurred without the offset project. The modeling must follow the requirements and methods 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). The computer simulation must model the expected growth in carbon stocks associated with pre-existing trees in the Project Area (i.e. those not planted as part of the Forest Project).

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 verification. At the time of the second verification, an estimated inventory of the all required carbon stocks at the time of the Forest Project's offset project commencement date must prepared by:

1. Assuming standing dead carbon stocks at the time of the Forest Project's offset project commencement date were equal to the standing dead carbon stocks measured and verified at the second verification.

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

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 in pre-existing trees (i.e. those not planted as part of the Forest Project) at the time of the Forest Project's offset project commencement date. The approved growth model or stand table projection used for the estimate must produce a result within 5 percent of current inventory data for pre-existing trees.

If the inventory of these carbon pools is deferred, the timing of the second verification is at the discretion of the Offset Project Operator or Authorized Project Designee (but must occur within 12 years of the initial verification). Reforestation Projects for which an initial inventory is deferred are not eligible to receive ARB or registry offset credits until after the second verification.

6.1.2 Estimating Baseline Carbon in Harvested Wood Products

Quantification Methodology
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 Appendix B) to determine the *average* amount of carbon in standing live carbon stocks (prior to delivery to a mill) that would have been harvested in each year of the baseline over 100 years. The result will be a uniform estimate of harvested carbon in each year of the baseline. This estimate is determined at offset project commencement using the same biomass equations used to calculate biomass in live trees, and will not change over the course of the offset project crediting period.
2. On an annual basis, determine the amount of harvested carbon that would have remained stored in wood products, averaged over 100 years, following the requirements and methods in Appendix C.

6.1.3 Determining Actual Onsite Carbon Stocks

Quantification Methodology
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 and requirements and methods for projecting forest inventory plot data using models is 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 requirements and methods in Appendix A, Section A.4.

6.1.4 Determining Actual Carbon in Harvested Wood Products

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

1. Determine the actual amount of carbon in standing live carbon stocks (prior to delivery to a mill) harvested in the current year (based on harvest volumes determined in Section 6.1.3).

2. Determine the amount of actual harvested carbon that will remain stored in wood products, averaged over 100 years, following the requirements and methods in Appendix C.

6.1.5 Quantifying Secondary Effects

Quantification Methodology
For Reforestation Projects, significant Secondary Effects can arise from two sources:
1. One-time combustion emissions associated with machinery used 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 Project Life.

To quantify combustion emissions associated with site preparation, 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 an offset project. If this results in a negative amount for total net quantified GHG reductions and GHG removal enhancements 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 GHG removal enhancements are accrued to achieve a positive balance. Negative GHG reductions and GHG removal enhancements due to site preparation emissions are *not* considered a reversal (Section 7.1).

Equation 6.2. Combustion Emissions Associated with Site Preparation

$$\mathbf{MC_y = (-1) \times (EF_{mc} \times PA)}$$

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 Tons 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 GHG emissions from the shifting of cropland and grazing activities each year, determine the appropriate “leakage” risk percentage for the project following the decision tree in Figure 6.3. The leakage risk percentage is only determined once, at offset project commencement. Each year, this percentage must be applied to 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. Emissions from Shifting Cropland and Grazing Activities

$$\mathbf{AS_y = (-1) \times L \times (\Delta\, AC_{onsite} - \Delta\, BC_{onsite})}$$

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
$\Delta\, AC_{onsite}$	=	Annual difference in actual onsite carbon (CO_2e) as defined in Equation 6.1.
$\Delta\, BC_{onsite}$	=	Annual difference in baseline onsite carbon (CO_2e) as defined in Equation 6.1.

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. Total Secondary Effect Emissions

$\mathbf{SE_y = (AS_y + MC_y)}$ *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.

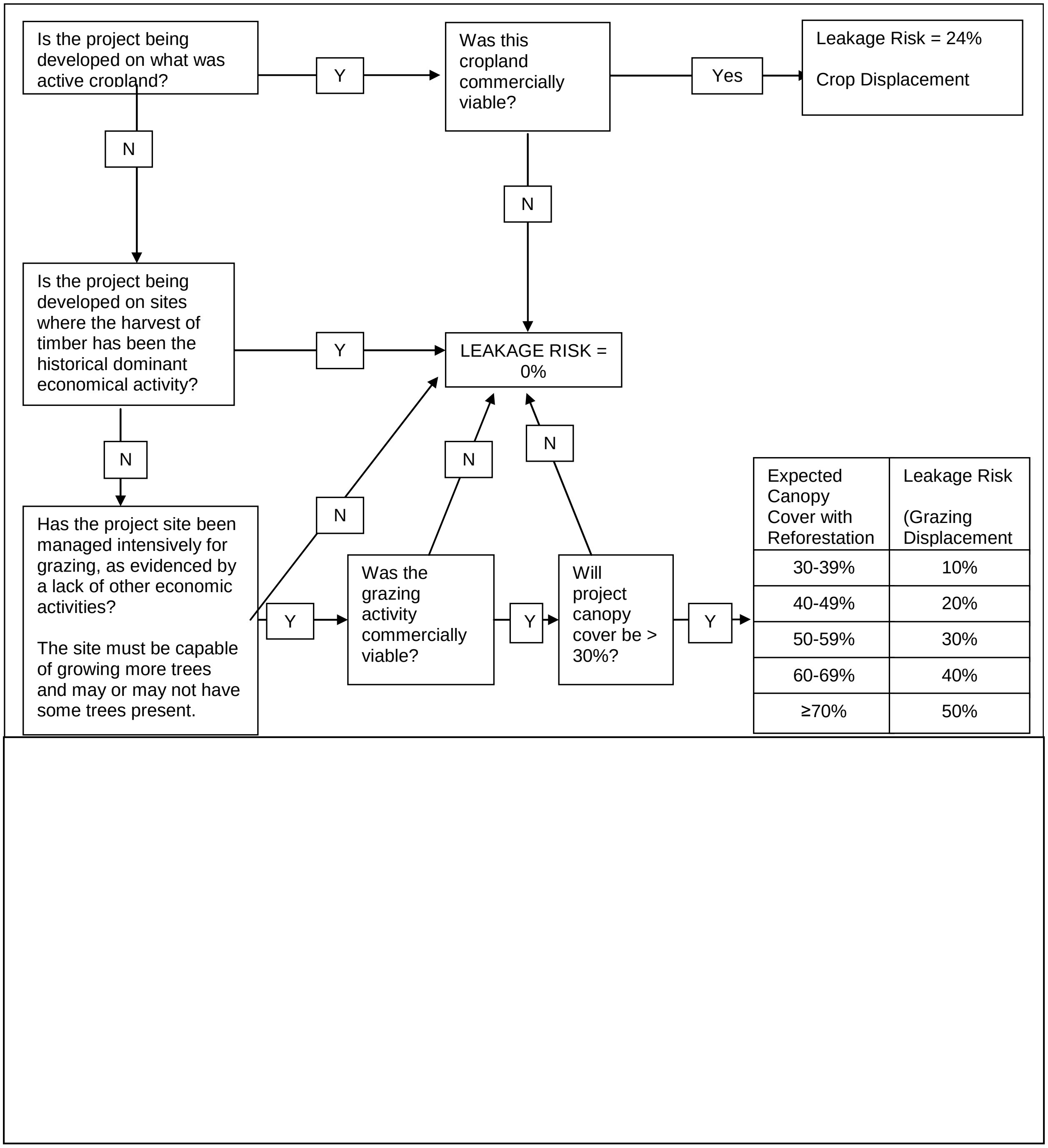


Figure 6.3. Activity Shifting ("Leakage") Risk Assessment for Reforestation Projects

6.2 Improved Forest Management Projects

Improved Forest Management Projects that take place on private land – or on land that is transferred to public ownership at the time the project is initiated – must estimate baseline onsite carbon stocks following the requirements and procedures in Section 6.2.1. Improved Forest Management Projects that take place on land that was publicly owned prior to the offset project commencement date must estimate baseline onsite carbon stocks following the requirements and procedures in Section 6.2.2. 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

Quantification Methodology

The baseline approach for Improved Forest Management Projects on private lands applies a standardized set of assumptions to offset 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 Forest Project's Assessment Area. In addition, baseline carbon stocks must be adjusted to reflect management practice on the Forest Owner's other landholdings in instances where Project Area carbon stocks are more than 20 percent below the carbon stocks on land within the same logical management unit. Finally, the baseline must be modeled to reflect all legal and economic constraints affecting the Project Area.

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

1. Determine the Common Practice level of above-ground standing live carbon stocks applicable to the Project Area.
2. Determine if the Project Area's initial above-ground standing live carbon stocks are above or below Common Practice.
3. Estimate baseline above-ground standing live carbon stocks, taking into account financial and legal constraints on harvesting in the Project Area, as well as the minimum baseline level applicable to the Project Area, as defined in the requirements for Step 3, below. The minimum baseline level will depend on whether initial above-ground standing live carbon stocks are above or below Common Practice.
4. Determine the baseline carbon stocks over 100 years for all required carbon pools in the Project Area.

For all calculations in this section, all values for "carbon stocks" should be expressed in metric tons of CO_2-equivalent.

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

As defined in this protocol, Common Practice refers to the average stocks of above-ground standing live carbon associated with the Assessment Area(s) covered by the Project Area. Common Practice is used as a reference point for baseline estimation. To determine a value for Common Practice, see Appendix F and the data available in the Forest Offset Protocol Resources section of ARB's website.

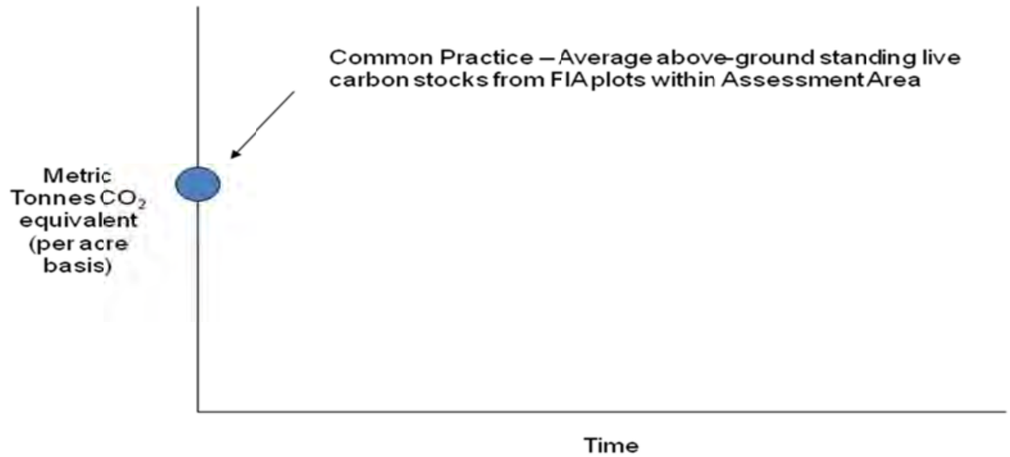


Figure 6.4. Common Practice as a Reference Point for Baseline Estimation

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

To determine if initial above-ground 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 in Appendix A), identify the metric tons of carbon contained in the *above-ground portion* of 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 value identified in Step 1.

Step 3 – Determine Baseline Above-Ground Standing Live Carbon Stocks

The baseline above-ground standing live carbon stocks must be determined by: (1) Modeling above-ground standing live carbon stocks through a series of growth and harvesting scenarios over 100 years; and (2) averaging the model results over the 100-year timeframe, so that the baseline is expressed as a single (average) value for above-ground standing live carbon stocks per acre in every year. The modeling must be performed following the requirements and methods in Appendix B and must meet the following conditions:

1. Growth and harvesting scenarios must reflect all legal constraints, following the requirements in Section 6.2.1.2.
2. Growth and harvesting scenarios must reflect any financial constraints, following the requirements in Section 6.2.1.3.
3. The averaged model results, expressed as above-ground standing live carbon stocks per acre, must not fall below a minimum baseline level (MBL). If initial above-ground standing live carbon stocks are above Common Practice, the MBL must be determined using the formula in Equation 6.5. If initial above-ground standing live carbon stocks are below Common Practice, then MBL must be determined using the formula in Equation 6.6.

A graphical example of a baseline meeting these conditions is provided in Figure 6.5 and Figure 6.6. Figure 6.5 shows the baseline before averaging; Figure 6.6 shows the baseline after averaging.

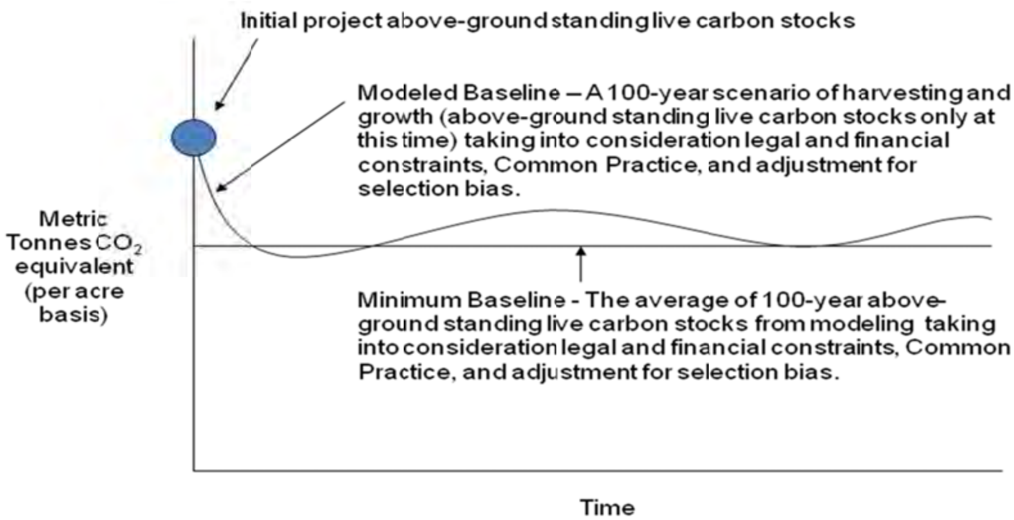


Figure 6.5. Modeling Standing Live Carbon Stocks Where Initial Stocks Are Above Common Practice

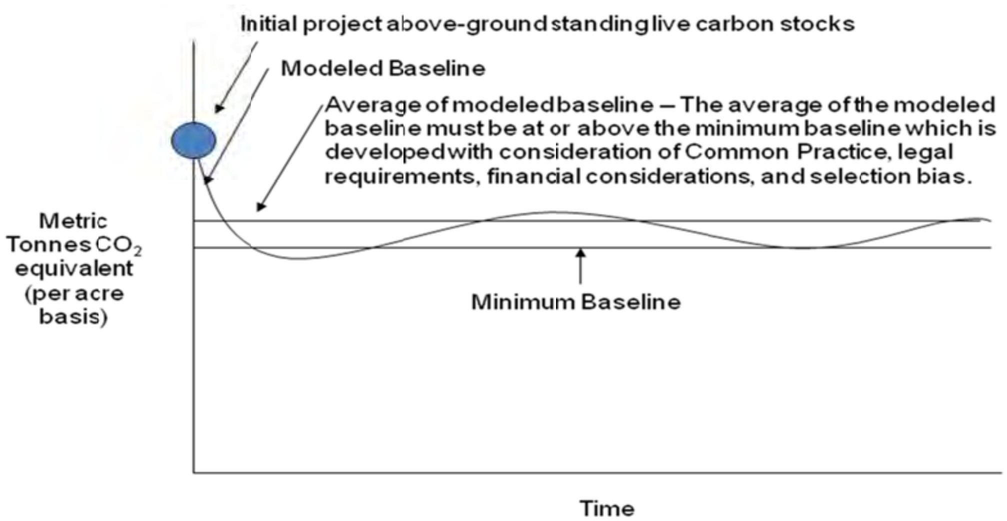


Figure 6.6. Averaging the Modeled Standing Live Carbon Stocks Where Initial Stocks Are Above Common Practice

Equation 6.5. Determining the Minimum Baseline Level Where Initial Stocks Are Above Common Practice

MBL = CP

Where,

MBL	=	Minimum baseline level (above-ground standing live carbon stocks)
CP	=	Common Practice (as determined in Step 1)

Equation 6.6. Determining the Minimum Baseline Level Where Initial Stocks Are Below Common Practice

MBL = MAX (MAX (HSR, ICS), MIN (CP, WCS))

Where,

MAX	=	The highest value in the set of values being evaluated.
MIN	=	The lowest value in the set of values being evaluated.
MBL	=	Minimum baseline level (above-ground standing live carbon stocks)
HSR	=	The “High Stocking Reference” for the Project Area. The High Stocking Reference is defined as 80 percent of the highest value for above-ground standing live carbon stocks per acre within the Project Area during the preceding 10-year period. To determine the High Stocking Reference, the Offset Project Operator or Authorized Project Designee must document changes in the Project Area’s above-ground standing live carbon stocks over the preceding 10 years. Figure 6.7 presents a graphical portrayal of a High Stocking Reference determination.
CP	=	Common Practice (as determined in Step 1)
ICS	=	Initial above-ground standing live carbon stocks per acre within the Project Area (as determined in Step 2)
WCS	=	The weighted average above-ground standing live carbon stocks per acre for all Forest Owner (and affiliate) landholdings within the same logical management unit as the Project Area. See Section 6.2.1.1 for requirements and methods for calculating WCS.

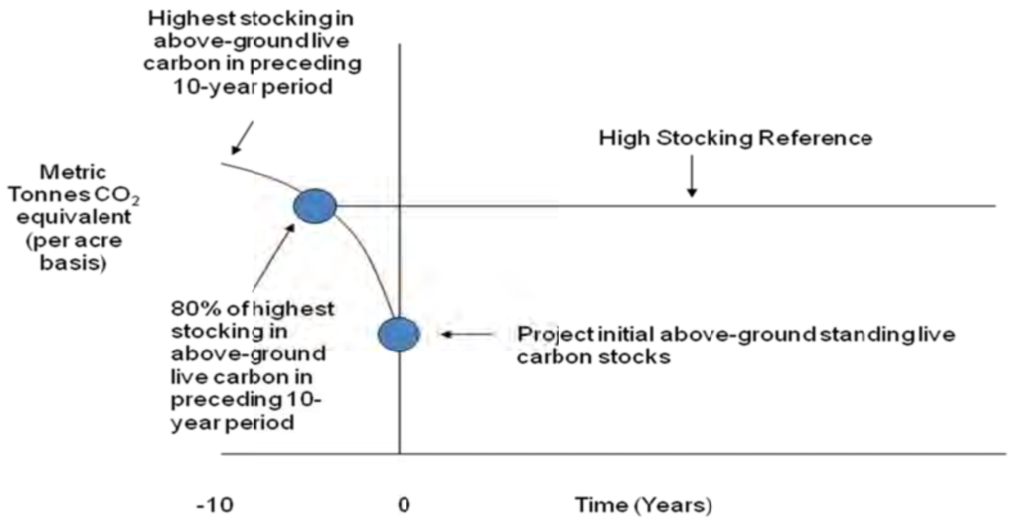


Figure 6.7. Determining a Project Area's High Stocking Reference
Note: It is possible for the High Stocking Reference to be higher than Common Practice, even where initial live-tree carbon stocks for the project are below Common Practice.

Step 4 – Determine the Baseline for All Carbon Pools

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

1. Estimate baseline carbon stocks for all other required carbon pools identified for the offset project (including below-ground carbon stocks, as well as standing dead carbon stocks where applicable). These carbon stocks must be modeled or estimated following the requirements and methods 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 above-ground standing live carbon stock baseline and the baseline for all other carbon stocks to produce a final baseline for all carbon pools (see Figure 6.8).

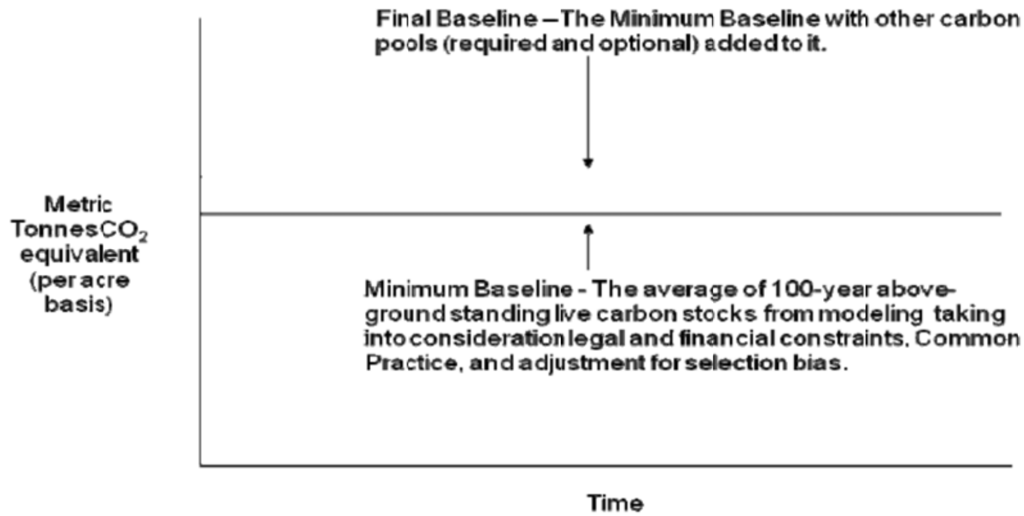


Figure 6.8. Final Baseline Incorporating All Required Carbon Stocks

6.2.1.1 Determining Weighted Average Carbon Stocks (WCS) on Lands in the Same Logical Management Unit as the Project Area

Quantification Methodology
Determining the minimum baseline level (MBL) for an Improved Forest Management project requires a comparison to carbon stocking levels on other lands within the same logical management unit (LMU) as the Project Area. The carbon stocking level within the LMU (expressed as the weighted average above-ground standing live carbon stocks per acre for all lands in the same LMU) is used as a parameter (WCS) for determining the MBL in Equation 6.6.

A “logical management unit” or “LMU” is defined as all land that the Forest Owner and its affiliate(s) (as defined below) either own in fee or hold timber rights on, and which it or they manage as an explicitly defined planning subunit. LMUs are generally characterized by unique biological, geographical, and/or geological conditions, are generally delimited by watershed boundaries and/or elevational zones, and contain unique road networks. In addition, an LMU must:

- Be a sustainable planning subunit as demonstrated by inventory reports and growth and harvest projections for the LMU or;
- Where even aged management is utilized, have a uniform distribution (by area) of 10-year age classes that extend to the normal rotation age (variation of any 10-year age class not to exceed 20%) or;
- Where uneven aged management is utilized, have between 33% and 66% of the forested stands exceeding the retention standards identified in the growth and harvest projections by a minimum of 25% (basal area).

An “affiliate” is defined as any person or entity that, directly or indirectly, through one or more intermediaries, controls or is controlled by or is under common control with the Forest Owner, including any general or limited partnership in which the Forest Owner is a partner and any limited liability company in which the Forest Owner is a member. For the purposes of this definition, "control" means the possession, direct or indirect, of the power to direct or cause the direction of the management and policies of a person, whether through the ownership of voting securities, by contract or otherwise, and "person" means an individual or a general partnership, limited partnership, corporation, professional corporation, limited liability company, limited liability partnership, joint venture, trust, business trust, cooperative or association or any other legally-recognized entity.

If an explicit, existing LMU containing the Project Area cannot be identified, the LMU must be defined by identifying all lands where the Forest Owner and its affiliate(s) (as defined above) either own in fee or hold timber rights within the same Assessment Area(s) covered by the Project Area. Assessment Areas covered by the Project Area are identified in Step 1, above, using the information in Appendix F.

To calculate WCS, estimate the above-ground standing live carbon stocks per acre for the entire LMU containing the Project Area (including the Project Area itself). This can be done using either existing inventory data, or a stratified vegetation-type analysis.

6.2.1.1.1 Calculating WCS Using Inventory Data

Quantification Methodology
If sufficient inventory data for LMU lands exist to quantify above-ground standing live carbon stocks for the entire LMU, then the formula in Equation 6.7 must be used to calculate WCS.

Equation 6.7. Formula for WCS Using Inventory Data

$$If\ \left|\left(1-\frac{ECS}{ICS}\right)\right| \leq 0.2, then\ WCS = ICS$$

$$If\ \left|\left(1-\frac{ECS}{ICS}\right)\right| > 0.2, then\ WCS = \frac{ICS \cdot PA + ECS \cdot EA}{PA + EA}$$

Where,

WCS	=	The weighted average above-ground standing live carbon stocks per acre within the LMU containing the Project Area
ICS	=	Initial above-ground standing live carbon stocks per acre within the Project Area
PA	=	Size of the Project Area in acres
ECS	=	Above-ground standing live carbon stocks per acre within the LMU *but excluding the Project Area* (EA), as determined from existing inventory data
EA	=	Size of the LMU in acres, e*xcluding the Project Area*

6.2.1.1.2 Calculating WCS Using Stratified Vegetation-Type Analysis

Quantification Methodology
If sufficient inventory data is not available for the LMU, a stratified vegetation-type analysis must be used to calculate WCS. To conduct this analysis, all landholdings within the LMU – including the Project Area – must be divided into vegetation types and size class/canopy cover categories as delimited in Table 6.2 with a resolution for classification no greater than 40 acres. Each vegetation class has a "carbon rating" provided in Table 6.2. WCS must be calculated using the

ratio of average carbon stocking on LMU lands relative to carbon stocking on Project Area lands (referred to as the "stratified carbon weighting factor" or SWF). The required formulas are specified in Equation 6.8 and Equation 6.9.

Equation 6.8. Formula for WCS Using Stratified Vegetation-Type Analysis

$$If \ \left|\left(1-\frac{ECS}{ICS}\right)\right| \leq 0.2, then\ WCS = ICS$$

$$If \ \left|\left(1-\frac{ECS}{ICS}\right)\right| > 0.2, then\ WCS = \frac{ICS \cdot PA + SWF \cdot ICS \cdot EA}{PA + EA}$$

Where,

WCS = The weighted average above-ground standing live carbon stocks per acre within the LMU containing the Project Area

ECS = Above-ground standing live carbon stocks per acre within the LMU, but excluding the Project Area (EA), as determined from existing inventory data

ICS = Initial above-ground standing live carbon stocks per acre within the Project Area

PA = Size of the Project Area in acres

SWF = The stratified carbon weighting factor for the LMU (from Equation 6.9 below)

EA = Size of the LMU in acres, e*xcluding the Project Area*

Equation 6.9. Formula for LMU Stratified Carbon Weighting Factor

$$SWF = \frac{\sum_i (PA_i \cdot CR_i)}{\sum_i PA_i} \div \frac{\sum_i (EA_i \cdot CR_i)}{\sum_i EA_i}$$

Where,

PA_i = Acres of the Project Area in forest vegetation type *i* (from Table 6.2)

EA_i = Acres of the LMU, e*xcluding the Project Area,* in forest vegetation type *i* (from Table 6.2)

CR_i = Carbon rating for forest vegetation type *i* (from Table 6.2)

Table 6.2. Vegetation Classes for Stratification

Forest Vegetation Description	Average Diameter (Breast Height)	Average Canopy Cover	Carbon Rating (metric tons CO_2e)
Brush	0"	NA	0
Regeneration	3"	NA	0.5
Pole-sized trees	6" - 12"	< 33%	2
Pole-sized trees	6" - 12"	33% - 66%	4
Pole-sized trees	6" - 12"	>66%	6
Small Sawlogs	12" - 20"	< 33%	4
Small Sawlogs	12" - 20"	33% - 66%	8
Small Sawlogs	12" - 20"	>66%	12
Large Sawlogs	20" - 36"	< 33%	8
Large Sawlogs	20" - 36"	33% - 66%	16
Large Sawlogs	20" - 36"	>66%	24
Very Large Trees	>36"	< 33%	16
Very Large Trees	>36"	33% - 66%	32
Very Large Trees	>36"	>66%	48

6.2.1.2 Consideration of Legal Constraints

In modeling the baseline for standing live carbon stocks, all legal constraints that could affect baseline growth and harvesting scenarios must be incorporated. 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 rental contracts and forest certifications, are not legal constraints. Habitat Conservation Plans (HCPs) and Safe Harbor Agreements (SHAs) that are in place more than one year prior to the offset project commencement date shall be modeled as legal constraints. HCPs and SHAs that are approved after the date one year prior to the offset project’~~s~~ commencement date are not considered legal constraints for the purpose of baseline modeling and may be disregarded from the baseline modeling.

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

1. Federal, state, 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
    c. Minimum stocking standards
2. Forest practice rules, or applicable Best Management Practices established by federal, state, 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, Habitat Conservation Plans, Safe Harbor Agreements, and deed restrictions, excepting an

encumbrance that was put in place and/or recorded less than one year prior to the offset project commencement date, as defined in Section 3.5.

For forest projects located in California, the baseline must be modeled to reflect all silvicultural treatments associated with any submitted, active, or approved timber harvest plans (THPs) at the time of offset project commencement that would affect harvesting and management within the Project Area during the Project Life. All legally enforceable silvicultural and operational provisions of a THP – including those operational provisions designed to meet California Forest Practice Rules requirements for achieving Maximum Sustained Production of High Quality Wood Products [14 CCR 913.11 (933.11, 953.11)] – are considered legal constraints and must be reflected in baseline modeling for as long as the THP will remain active. For portions of the Project Area not subject to THPs (or over time periods for which THPs will not be active), baseline carbon stocks must be modeled by taking into account any applicable requirements of the California Forest Practice Rules and all other applicable laws, regulations, and legally binding commitments that could affect onsite carbon stocks. On a case-by-case basis, the California Department of Forestry and Fire Protection (Cal FIRE) may assist in identifying minimum carbon stocking levels that would be effectively required under California Forest Practice Rules.

6.2.1.3 Consideration of Financial Constraints

In modeling the baseline for standing live carbon stocks, financial constraints that could affect baseline growth and harvesting scenarios must be included. It must be demonstrated 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 Forest 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 percent of project species composition based on trees per acre)

6.2.2 Estimating Baseline Onsite Carbon Stocks – Public Lands

Quantification Methodology

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
    b. Anticipating how current 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 (under the baseline stocks) achieves a stand composition consistent with comparable forested areas that have been relatively free of harvest over the past 60 years.

To anticipate how current public policy will affect onsite carbon stocks, the baseline must be modeled following the requirements and methods 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

Quantification Methodology

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* amount of carbon in standing live carbon stocks (prior to delivery to a mill) that would have been harvested in each year of the baseline over 100 years. The result will be a uniform estimate of harvested carbon in each year of the baseline. This estimate is determined at offset project commencement, using the same biomass equations used to calculate biomass in live trees, and will not change over the course of the project.
    a. For offset projects on private lands, the amount of harvested carbon 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 offset projects on public lands, the amount of harvested carbon must be derived from the growth and harvesting regime assumed in the baseline for onsite carbon stocks derived in Section 6.2.2.
2. On an annual basis, determine the amount of harvested carbon that would have remained stored in wood products, averaged over 100 years, following the requirements and methods in Appendix C.

6.2.4 Determining Actual Onsite Carbon Stocks

Quantification Methodology

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 and requirements and methods for projecting forest inventory plot data using models are 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 requirements and methods in Appendix A, Section A.4.

6.2.5 Determining Actual Carbon in Harvested Wood Products

Quantification Methodology

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

1. Determine the actual amount of carbon in standing live carbon stocks (prior to delivery to a mill) harvested in the current year (based on harvest volumes determined in Section 6.2.4).
2. Determine the amount of actual harvested carbon that will remain stored in wood products, averaged over 100 years, following the requirements and methods in Appendix C.

6.2.6 Quantifying Secondary Effects

Quantification Methodology

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. Equation 6.10 must be used to estimate Secondary Effects for Improved Forest Management projects:

Equation 6.10. Secondary Effects Emissions

$$If \sum_{n=1}^{y}(AC_{hv,n} - BC_{hv,n}) > 0, then\ \ SE_y = 0$$

$$If \sum_{n=1}^{y}(AC_{hv,n} - BC_{hv,n}) < 0, then\ SE_y = (AC_{hv,y} - BC_{hv,y}) \times 20\%$$

Where,

SE_y	=	Estimated annual Secondary Effects (used in Equation 6.1.)
$AC_{hv,\ n}$	=	Actual amount of onsite carbon harvested in reporting period n (prior to delivery to a mill), expressed in CO_2-equivalent tons
$BC_{hv,\ n}$	=	Estimated average baseline amount of onsite carbon harvested in reporting period n (prior to delivery to a mill), expressed in CO_2-equivalent tons, as determined in Step 1 of Section 6.2.3
Y	=	The current year or reporting period

6.3 Avoided Conversion Projects

6.3.1 Estimating Baseline Onsite Carbon Stocks

Quantification Methodology

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; and
2. Discount for the uncertainty of conversion probability.

Step 1 - Characterizing and Projecting the Baseline

The project baseline must be characterized 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, taking into consideration any laws, statutes, regulations, or other legal mandates that affect land use conversion or removal of onsite carbon stocks. The rate of conversion and removal of onsite carbon stocks must be estimated by either:
    a. 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
    b. In the absence of specific documentation, identifying default Total Conversion Impact and Annual Conversion values from Table 6.3.
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 carbon pools, as identified in Section 5.3.

Table 6.3. Default Avoided Conversion

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 conversion in the next column.)	Annual Conversion This is the assumed annual 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 = min(100, (P*3 / PA)*100) *Where:* TC = % total conversion (TC cannot exceed 100%) PA = the Project Area (acres) identified in the appraisal P = the number of unique parcels that would be formed on the project area as identified in the appraisal *Each parcel is assumed to deforest 3 acres of forest vegetation.	Estimate using the following formula: AC = TC / 10 *Where:* AC = % annualized 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.

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 offset project's quantified GHG reductions and GHG removal enhancements. If quantified GHG reductions and GHG removal enhancements for the year are positive (i.e. $[(\Delta\ AC_{onsite} - \Delta\ BC_{onsite}) + (AC_{wp,\ y} - BC_{wp,\ y}) * 80\% + SE_y] > 0$ in Equation 6.1) then use the following formula (Equation 6.11) to calculate the appropriate Avoided Conversion Discount factor, ACD. If quantified GHG reductions and removals for the year are negative, then ACD must equal zero.

Equation 6.11. Avoided Conversion Discount Factor

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

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

Quantification Methodology

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 amount of carbon in standing live carbon stocks (prior to delivery to a mill) that would have been harvested in each year, consistent with the rate of reduction in baseline standing live carbon stocks determined in Section 6.3.1. This projection is determined at offset project commencement, using the same biomass equations used to calculate biomass in live trees, and will not change over the course of the offset project.
2. On an annual basis, determine the amount of harvested carbon that would have remained stored in wood products, averaged over 100 years, following the requirements and methods in Appendix C.

6.3.3 Determining Actual Onsite Carbon Stocks

Quantification Methodology
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. Methods 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 requirements and methods in Appendix A, Section A.4.

6.3.4 Determining Actual Carbon in Harvested Wood Products

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

1. Determine the actual amount of carbon in standing live carbon stocks (prior to delivery to a mill) harvested in the current year (based on harvest volumes determined in Section 6.3.3).
2. Determine the amount of actual harvested carbon that will remain stored in wood products, averaged over 100 years, following the requirements and methods in Appendix C.

6.3.5 Quantifying Secondary Effects

Quantification Methodology
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, use Equation 6.12.

The value for Secondary Effect emissions will always be negative or zero.

Equation 6.12. Secondary Effects Emissions

$$SE_y = (-1) \times CDR\% \times (\Delta AC_{onsite} - \Delta BC_{onsite}) \text{ or } 0\text{, whichever is lower}$$

Where,

SE_y	=	Secondary Effect GHG emissions caused by the project activity in year y (Equation 6.1)
CDR	=	Conversion displacement risk value, assumed to be 3.6% for all forest lands
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

7 Ensuring the Permanence of Credited GHG Reductions and GHG Removal Enhancements

The Regulation requires that credited GHG reductions and GHG removal enhancements be "permanent." Permanence of Forest project GHG reductions and removals is addressed through three mechanisms:

1. The requirement for all offset projects to monitor onsite carbon stocks, submit annual Offset Project Data Reports, and undergo third-party verification of those reports with site visits at least every six years for the duration of the Project Life.
2. The regulatory obligation for all intentional reversals of GHG reductions and GHG removal enhancements to be compensated for through retirement of other Compliance Instruments.
3. The maintenance of a Forest Buffer Account by ARB to provide insurance against reversals of GHG reductions and GHG removal enhancements due to unintentional causes (including natural disturbances such a fires, pest infestations, or disease outbreaks).

GHG reductions and GHG removal enhancements 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 may therefore result in an unintentional reversal, 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. Under this protocol, reversals due to controllable agents are considered intentional as defined in the Regulation. The Offset Project Operator or Authorized Project Designee is required to identify and quantify the risk of reversals from different agents based on offset project-specific circumstances. The resulting risk rating determines the quantity of ARB offset credits that the project must contribute to the Forest Buffer Account to insure against unintentional reversals.

7.1 Identifying a Reversal

The Offset Project Operator or Authorized Project Designee must demonstrate, through annual reporting and periodic verification, that stocks associated with credited GHG reductions and GHG removal enhancements are maintained for a period of time considered to be permanent. For purposes of this protocol 100 years is considered permanent. If the quantified GHG reductions and GHG removal enhancements (i.e. QR_y in Equation 6.1) in a given year are negative, and ARB offset credits were issued to the Forest Project in any previous year, it is considered 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 QR_y.

7.2 Insuring Against Reversals

Unintentional reversals are insured against by contributing a percentage of ARB offset credits to a Forest Buffer Account. The amount of the contribution is based on a project-specific risk evaluation.

7.2.1 About the Forest Buffer Account

A Forest Buffer Account is a holding account for ARB offset credits issued to Forest Project, which is administered by ARB. All Forest Projects must contribute a percentage of ARB offset credits to the Forest Buffer Account any time ARB offset credits are issued by ARB for verified GHG reductions and GHG removal enhancements. 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 unintentional reversal of credited GHG reductions and GHG removal enhancements (as defined in Section 7.3), ARB offset credits from the Forest Buffer Account will be retired in an amount equal to the total amount of carbon that was reversed (measured in metric tons of CO_2-equivalent) according to the process identified in the Regulation. A Forest Buffer Account therefore acts as a general insurance mechanism against unintentional reversals for ARB offset credits issued to Forest Projects.

7.2.2 Contributions to the Forest Buffer Account

ARB offset credits will be contributed to the Forest Buffer Account pursuant to the Regulation based on the reversal risk rating for a project as determined by the requirements and methods in Appendix D. The risk rating must be determined prior to listing, and recalculated in every year the project undergoes verification. Forest Owners who record a Qualified Conservation Easement in conjunction with implementing a Forest Project will receive a lower risk rating (see Appendix D).

7.3 Compensating for Reversals

The Regulation defines reversals and establishes how reversals will be compensated.

7.3.1 Unintentional Reversals

The Regulation defines unintentional reversals. Requirements for compensating unintentional reversals are set forth in the Regulation.

7.3.2 Intentional Reversals

The Regulation defines intentional reversals. Requirements for intentional reversals are set forth in the Regulation.

7.4 Disposition of Forest Projects after a Reversal

Provisions related to the disposition of a Forest Project after a reversal are set forth in the Regulation. These provisions dictate under what circumstances a Forest Project that undergoes an intentional or unintentional reversal would be terminated and under what circumstances the Forest Project may continue without termination.

8 Offset Project Monitoring

General requirements for monitoring, reporting, and record retention are provided in the Regulation. The Offset Project Operator or Authorized Project Designee must conduct monitoring activities and submit Offset Project Data Reports in accordance with the Regulation and this protocol. Monitoring is required for a period of 100 years following the final issuance of any ARB or registry offset credits to an offset project.

For Forest Projects, monitoring activities consist primarily of updating a project's forest carbon inventory. ARB requires a complete inventory of carbon stocks to be reported each year. This complete inventory must be maintained and updated throughout the Project Life.

8.1 Forest Carbon Inventory Program

Prior to a Forest Project's first verification, a documented forest carbon inventory program, including an inventory monitoring plan and a modeling plan, must be established detailing the specific methods that will be used to update the project's forest carbon inventory on an annual basis. The forest carbon inventory program must adhere to the requirements and methods in Appendices 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

The Offset Project Operator or Authorized Project Designee is required to report the Forest Project's onsite carbon stocks each year in an Offset Project Data Report. The Offset Project Data Report must include an estimate of carbon stocks in all required carbon pools. The estimate must reflect the appropriate confidence deduction as determined by the steps in Appendix A, Section A.4. Annual onsite 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. Modeling growth in 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.

Specific methods used to update the forest inventory must follow the inventory methodologies approved at the time the project is initially verified. Modifications to inventory methodologies must be approved in advance by a third-party verification body and by ARB, and documented in the change log.

9 Reporting Requirements

This section provides supplemental requirements for reporting in addition to requirements contained in the Regulation. Offset Project Data Reports must be submitted at the conclusion of every Reporting Period.

9.1 Offset Project Documentation

In order for the offset project to be Listed, all of the information specified in the Project Listing Requirements in Section 9.1.1 must be submitted, along with any additional information specified in the Regulation. Reporting deadlines and record retention requirements are contained in the Regulation.

All reports that reference carbon stocks must be submitted with the oversight of a Professional Forester. If the offset project is located in a jurisdiction without a Professional Forester law or regulation, then a Professional Forester must either have the Certified Forester credentials managed by the Society of American Foresters, or other valid professional forester license or credential approved by a government agency in a different jurisdiction.

9.1.1 Offset Project Listing Requirements

The listing information in this section must be submitted by the Offset Project Operator or Authorized Project Designee prior to the Listing of the offset project. This information is also submitted as part of the first Offset Project Data Report, and is subject to verification at the initial offset project verification. The following listing information must be submitted no later than the date at which the Offset Project Operator or Authorized Project Designee submits the first Offset Project Data Report:

9.1.1.1 All Offset Projects[7]

1. Offset project name.
2. Offset project contact information, including name, phone number, address, and email address for:
    a. Offset Project Operator
    b. Authorized Project Designee (if applicable);
3. Whether the Offset Project Operator is the owner in fee for the project area.
    a. If yes, provide documentation (e.g. deed of trust, title report) showing the Offset Project Operator's ownership interest in the property and its interest in the trees and standing timber on the property.
    b. If no, explain how the entity identified as the Offset Project Operator has the right to undertake and list the project and provide documentation supporting the explanation.
4. Offset project type (reforestation, improved forest management, or avoided conversion).
5. A description of the management activities that will lead to increased carbon stocks in the Project Area, compared to the baseline.

[7] Reforestation projects as qualified in section 6.1 can defer the items that are marked with an asterisk until the second site-visit verification.

6. Indicate if the offset project occurs on public or private lands, and further specify if the offset project occurs on any of the following categories of land:
   a. Land that is owned by, or subject to an ownership or possessory interest of a Tribe;
   b. Land that is "Indian lands" of a Tribe, as defined by 25 U.S.C. §81(a)(1); or
   c. Land that is owned by any person, entity, or Tribe, within the external borders of such Indian lands.
7. Offset project commencement date, with an explanation and justification of the commencement date.
   a. Specify the action(s) that identify the offset project commencement date.
8. A statement as to whether any GHG reductions or GHG removal enhancements associated with the Project Lands have ever been listed or registered with, or otherwise claimed by, another registry or program, or sold to a third party prior to listing, including;
   a. Have any lands within the Project Area ever been listed or registered with an offset project registry or program in the past?
   b. Have greenhouse gas emission reductions or removal enhancements associated with lands within the Project Area been credited or claimed for the purpose of greenhouse gas mitigation or reduction goals, whether in a voluntary or regulatory context?
   c. If yes, identify the registry or program (include vintages and reporting period).
9. A statement as to whether the project is being implemented and conducted as the result of any law, statute, regulation, court order, or other legally binding mandate? If yes, explain.
10. Declaration that the offset project does *not* employ broadcast fertilization.
11. If the Forest Project is located on public land, a description and copies of the documentation demonstrating explicit approval of the offset project's management activities and baseline including any public vetting processes necessary to evaluate management and policy decisions concerning the offset project.
12. If the Forest Project is located on the following categories of land, a description and copies of documentation demonstrating that the land within the Project Area is owned by a tribe or private entities:
    a. Land that is owned by, or subject to an ownership or possessory interest of a Tribe;
    b. Land that is "Indian lands" of a Tribe, as defined by 25 U.S.C. §81(a)(1); or
    c. Land that is owned by any person, entity, or Tribe, within the external borders of such Indian lands.
13. If commercial harvesting is either planned or ongoing within the Project Area, 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 3.8.1).
14. A description of how the offset project meets (or will meet) the definition of "Natural Forest Management" (refer to Section 3.8.2), including:
    a. Composition of native species;
    b. Distribution of age classes / sustainable management;
    c. Structural elements (standing and lying dead wood);
15. Descriptions and maps of the Project Area boundaries that include:
    a. Governing jurisdictions, and latitude/longitude coordinates
    b. Public and private roads (map)
    c. Towns (map)

d. Major watercourses (4th order or greater), water bodies, and watershed description (map)
e. Topography (map)
f. Townships, ranges, and sections or latitude and longitude (map)
g. Existing land cover and land use (description with optional map)
h. Forest vegetation types (description with optional map)
i. Site classes (description with optional map)
j. Land pressures and climate zone/classification (description with optional map)
k. Historical land uses, current zoning, and projected land use within project area and surrounding areas (description with optional map)
l. A georeferenced shape file (or other electronic file that can be read in a geographic information system) that clearly identifies the project area and boundaries. This file may constitute the required map if it includes the required map information listed above.

16. Identify what assessment area or areas contain lands within the Project Area.
    a. Include how many acres of project lands fall within each assessment area.
    b. Include a value for total project area acreage.
17. General description of the forest conditions within the Project Area:
    a. Species (tree) composition;
    b. Age class distribution;
    c. Management history;
18. Indicate whether the project will employ a Qualified Conservation Easement.
    a. If yes, include the date the Qualified Conservation Easement was or will be recorded, the terms that affect forest management within the easement, and provide a copy of the Qualified Conservation Easement to ARB.
19. *A description of the inventory methodology for each of the carbon pools included in the Forest Project's Offset Project Boundary. The inventory methodology must describe the information required in Appendix A.3.
20. *A description of the calculation methodologies for determining metric tons per acre for each of the carbon pools included in the Offset Project Data Report.
21. *A modeling plan, following the requirements and methods in Appendix B, Section B.3.
22. *A diagram of the final baseline incorporating all required carbon stocks.
23. *A summary of the inventory of carbon stocks for each carbon pool.
24. *A summary of inventory confidence statistics.
25. *A 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 metric tons CO_2-equivalent in the y-axis. The graph should be supported with written characterizations that explain any annual changes in baseline carbon stocks over time.
26. *An estimate of carbon that will be stored long-term in harvested wood products in the baseline.
27. *Calculation of the offset project's reversal risk rating and contribution to the Forest Buffer Account.

9.1.1.2 Reforestation Projects

In addition to the information in Section 9.1.1.1, the following information must be provided for Reforestation projects:

1. An explanation of how the Project Lands, at the time of offset project commencement, 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.
4. List any laws, statutes, regulations or other legal mandates that would encourage or require reforestation on the project area.

9.1.1.3 Improved Forest Management Projects on Private Lands

In addition to the information in Section 9.1.1.1, the following information must be provided for Improved Forest Management projects on private lands:

1. Documentation that the Project Area 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. To determine the High Stocking Reference, changes in the Project Area's live-tree carbon stocks over the preceding 10 years must be documented.
    a. Include an affidavit testifying that the inventory depicted over the past 10 years is reasonably accurate.
    b. 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 6.2.1.2).
    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 6.2.1.3.

9.1.1.4 Improved Forest Management Projects on Public Lands

In addition to the information in Section 9.1.1.1, the following information must be provided for Improved Forest Management projects on public lands:

1. Documentation demonstrating that the offset 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 public policy will affect onsite carbon stocks per the requirements of Section 6.2.2.

3. An explanation of how current 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.

9.1.1.5 Avoided Conversion Projects

In addition to the information in Section 9.1.1.1, the following information must be provided for Avoided Conversion projects:

1. Documentation demonstrating the planned or completed dedicating of the land in the Project Area to continuous forest cover through a Qualified 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).
8. Where the anticipated alternative land use is commercial, residential or agricultural use, indicate the maximum slope of the project area.
9. Where the anticipated alternative land use is mining, describe the extent of mineral resources existing in the Project Area.
10. Where the anticipated alternative land use is commercial, residential or recreational use, indicate:
    a. The proximity of the Project Area to metropolitan areas;
    b. The proximity of the Project Area to grocery and fuel services and accessibility of those services;
    c. Population growth (people per year) within 180 miles of the Project Area.

9.2 Offset Project Data Report

Offset Project Operators or Authorized Project Designees must submit an Offset Project Data Report each year according to the reporting schedule in the Regulation. The listing information in Section 9.1.1 must be included in the initial Offset Project Data Report, and is subject to verifier review during the initial verification. All Offset Project Data Reports must include the information in section 9.2.1.

9.2.1 Annual Reporting

An Offset Project Data Report must be prepared for each reporting period during the Project Life. Offset Project Data Reports must be provided to verification bodies whenever a Forest Project undergoes verification. Offset Project Data Reports must contain an annual update of the project's forest carbon inventory (Section 8.2). Each report must also contain the following information. Reforestation Projects, as qualified in Section 6.1, can defer the items that are marked with an asterisk until submitting the offset project data report that will undergo the second verification.

1. Offset project name.
2. Offset project contact information, including name, phone number, address, and email address for:
    a. Offset Project Operator
    b. Authorized Project Designee (if applicable);
3. Reporting Period.
4. A statement as to whether the Forest Project and associated Project Lands have met and been in compliance with all local, state, or federal regulatory requirements during the reporting period. If not, an explanation of the non-compliance must be provided.
5. A statement as to whether all the information submitted for project Listing is still accurate. If not provided updates to the relevant listing information.
6. An updated estimate of the reporting period's carbon stocks in all required carbon pools.
7. *The appropriate confidence deduction for the forest carbon inventory following the requirements and methods in Appendix A, Section A.4)
8. *An explanation of any decrease over any 10-year consecutive period in the standing live carbon pool.
9. Any changes in the status of the Forest Owner including, if applicable per Section 3.8.1, the acquisition of new forest landholdings.
10. A description of how the project meets (or will meet) the definition of "Natural Forest Management" (refer to Section 3.8.2), including progress on criteria that have not been fully met in previous years.
11. *An estimate of reporting-year harvest volumes and associated carbon in harvested wood products.
12. *Estimated mill efficiency, as determined following the method in Appendix C, Section C.2.
13. The baseline carbon stock estimates for all required carbon pools for the reporting period, as determined following the requirements in Section 6 and approved at the time of the project's registration.
14. An estimate of Secondary Effects, following calculation steps and/or factors provided in Section 6 and approved at the time of the offset project listing.
15. The uncertainty discount for avoided conversion projects, as determined following the requirements of Section 6.3 and approved at offset project listing. (After the initial verification, the uncertainty discount does not change.)
16. A calculation of total net GHG reductions and GHG removal enhancements (QR_y) for the reporting period, following the requirements in Section 6.
17. If a reversal has occurred during the previous reporting period, the report must include a written description and explanation of the reversal, whether the reversal has been classified as intentional or unintentional, and the status of compensation for the reversal.
18. *The offset project's reversal risk rating, as determined following the requirements in Section 7 and Appendix D.
19. *A calculation of the offset project's Forest Buffer Account contribution.
20. For the initial Offset Project Data Report: Projections of baseline and actual harvesting volumes from the Project Area over 100 years.

9.2.2 Additional Reporting for Verification Years

Forest Projects must be verified at least every six years. If verification is less frequent than annual, Offset Project Data Reports must include the following additional information on aggregated GHG emission reductions or removal enhancements since the last verification:

1. Annual estimates of carbon stocks for all required carbon pools reported during each year since the last verification.
2. Confidence deduction for the forest carbon inventory applied for each year since the last verification for the project, if applicable.
3. Baseline carbon stock estimates for all required carbon pools reported during each year since the last verification.
4. Estimate of Secondary Effects reported during each year since the last verification.
5. If a reversal has occurred during the previous six years, the report must provide a written description and explanation of the reversal, whether the reversal has been classified as intentional or unintentional, and the status of compensation for the reversal.
6. Calculation of the offset project's Forest Buffer Account contribution for each year since the last verification.
7. Calculation of total net GHG reductions and GHG removal enhancements (QR_y) reported for each reporting period since the last verification.

9.3 Reporting and Verification Cycle

Upon completion of a reporting period, the Offset Project Operator or Authorized Project Designee must annually submit an Offset Project Data Report according to the schedule specified in the Regulation for each reporting period. Reporting periods are defined in the Regulation. Offset Project Data Reports must be verified (including a site visit) by an ARB-accredited verification body according to the schedule and requirements in the Regulation and Section 10.

A Forest Project is considered automatically terminated (see Section 3.4) if the Offset Project Operator or Authorized Project Designee chooses not to report data and undergo verification at required intervals.

Reforestation Projects for which an initial inventory is deferred are not eligible to receive ARB or registry offset credits until after the second verification.

10 Verification

10.1 Regulatory Verification Requirements

Offset Project Data Reports must be verified in accordance with the regulatory verification requirements in Subarticle 13 of the Regulation and this protocol. Failure to conform to any requirements in this protocol or the Regulation, as applicable, will result in an adverse verification statement. Forest Projects are not eligible to receive a qualified positive offset verification statement.

10.2 Additional Verification Requirements

In addition to the offset project verification requirements in the Regulation, verification of Offset Project Data Reports for Forest Projects must include the following:

10.2.1 Initial Verification

During the initial full verification, the following is required:

1. A detailed review of all required Listing Information during the initial verification.
    a. Include a thorough review of documentation and maps to verify the acreage of the Project Area enrolled in a Forest Project.

10.2.2 Full Verification

During every full verification, including the initial verification, the following is required of the offset verifier:

1. A detailed review of the forest carbon inventory, including:
    a. Inventory methodology and sampling design;
    b. Inventory update processes;
    c. Measurement of sample plots and sample plot locations;
    d. Lifetime and updating of sample plots, as applicable;
    e. Stratification methods, if applicable;
    f. Biomass equations and calculations;
    g. Incorporation of growth and harvest modeling and data;
    h. Documentation of inventory methods and procedures, including procedures for data quality assurance and quality control.
2. Identification and re-measurement of a selection of sample plots, along with a comparison with inventory data to have reasonable assurance that sample plots are measured accurately using the methods required in this section.

    The following paragraphs use specific terms that may not always have the same meanings in varying contexts. For the purposes of this verification the following terms and definitions apply:

- Stand: An individual unit or polygon that is relatively homogeneous in terms of the carbon stocking within its borders. For live and dead trees, the determination of stand boundaries is usually based on forest vegetation attributes, such as species, size (age), and density characteristics. For soils, the determination of soil stand boundaries is made on similar soil types.
- Stratum: A group of stands that contain a similar attribute, such as vegetation or soils attributes.
- Strata: Plural of stratum. The set of different groupings for a specific attribute, such as vegetation or soil.

The offset verifier will sample plots consistent with the objectives of a random, risk-based and efficient approach. In doing so, the offset verifier may weight the probability of selecting strata and plots based on appropriate criteria such as carbon stocking, access difficulty, and vegetation heterogeneity. Verifiers may choose to sample project plots within strata with a cluster design. The selection of a stratum may use probability proportional to carbon stocks or probability proportional to error risk.

The verification procedures described below must be applied independently for each applicable carbon pool/applicable combination of pools that is included in the Offset Project Boundary:

- Standing live and dead trees;
- Soil;
- Lying dead wood; and
- Shrubs and herbaceous understory.

Sequential statistical methods are used to minimize the verification effort when verification and project sample data agree. Sequential approaches have stopping rules rather than fixed sample sizes. With each successive plot, or series of plots, analyzed by the offset verifier, the stopping rules indicate to the offset verifier a) to continue to the next plot(s) since the results do not indicate either a bias or an agreement and further testing is required, b) stop as the testing indicates a bias, or c) stop as the testing indicates agreement. When a stopping rule is met then the result is evaluated. Verification of sample plots is successful after a minimum number of successive plots in a sequence indicate agreement. Where the stopping rules indicate the presence of a bias, additional verification plots may be collected after that time if it is felt that random chance may have caused the test to fail and a convergence towards agreement is expected with additional samples. For effective application of the sequential statistics in the field, the determination of when the stopping rule is met is determined at the end of each sampling day, which will include the full set of plots measured in that day.

Stands of a given stratum must be independently selected using a random selection design. Plots, or clusters, must be independently selected within a stand using a random or systematic design. No more than 6 plots or clusters can be assigned to a stand, unless the groups of plots required for verification exceed the number of stands that exist for the offset project. If the offset project is not stratified for each applicable pool, the offset verifier shall allocate the plots or clusters on a randomized basis. If the offset verifier uses a cluster design, the mean of the cluster accounts for one observation (plot). Plots may be measured and assessed one at a time or in reasonable batches that correspond to logistical realities such as crew-days of effort. Verification sampling may be conducted using clustering or systematic approaches to facilitate efficiency.

When the project area has been stratified for the purposes of estimating the Forest Project's inventory based on common characteristics for each carbon pool, the offset verifier shall select three strata for each applicable carbon pool based on the offset verifier's evaluation of risk. Consideration of risk should be based on the overall importance of a given stratum to the project's total stocks and the presumption that any given stratum is inaccurately measured. The selection of stands to verify within a given stratum must be random. The minimum number of sample plots varies by project size and number of strata verified. (Table 10.1).

Table 10.1. Minimum number of sample plots in sequence, as a function of project size.

Test	Number of Strata Verified	Project Acres				
		<100	100 - 500	501 - 5,000	5,000 - 10,000	> 10,000
Paired/Unpaired	3	2	3	4	5	6
	2	4	6	8	10	12
	1	8	12	16	20	24

There are two possible statistical procedures that can be applied to the stratum-level verifications. A paired test can be applied when plot locations can be found and it is statistically appropriate (i.e. plot measurements can be replicated) to use a paired test. An unpaired test can be applied when plots cannot be relocated. The range of acceptable error (δ, delta) is fixed at 10 percent.

Assigning Risk to Strata: The offset verifier must determine for each applicable pool or combination of pools if the Offset Project Operator or Authorized Project Designee has stratified the project area into strata that reflect common characteristics that influence carbon stocks. The offset verifier may presume risk exists in the highest stocked strata, strata that are unique or difficult to access due to topographical, vegetative, or other physical barrier, strata that represent a large portion of the project's inventory due to the area they represent, or any other risk perceived by the offset verifier. The determination of risk must be applied to the stratum as a unit and not individual stands of a given stratum.

Selecting Strata based on Risk: Based on the assessment of risk, the offset verifier will query, or request that the Offset Project Operator or Authorized Project Designee query, the set of stands that are associated with the strata selected. The queried stands must have an identifier which can be based on the Offset Project Operator or Authorized Project Designee's identification convention or one assigned by the offset verifier. Three strata must be selected, or the maximum number of strata stratified by the Offset Project Operator or Authorized Project Designee for each pool. Table 10.2 displays an example of ordered strata for standing live and dead trees selected by stratum with random numbers assignments.

Table 10.2. Stands selected by vegetation strata and risk class with random number assignments.

Stand Number	Stratum (from Forest Owner or Verifier)	Risk Class	Order of Random Selection
2	Dense Intermediate Conifers	High Stocking	5
3	Dense Intermediate Conifers	High Stocking	3
4	Dense Intermediate Conifers	High Stocking	1
8	Dense Intermediate Conifers	High Stocking	8
9	Dense Intermediate Conifers	High Stocking	2
10	Dense Intermediate Conifers	High Stocking	1
15	Dense Intermediate Conifers	High Stocking	4
18	Dense Intermediate Conifers	High Stocking	7
Stand Number	**Stratum (from Forest Owner or Verifier)**	**Risk Class**	**Order of Random Selection**
8	Dense Mature Conifers	High Stocking	4
9	Dense Mature Conifers	High Stocking	3
10	Dense Mature Conifers	High Stocking	5
15	Dense Mature Conifers	High Stocking	2
18	Dense Mature Conifers	High Stocking	1
Stand Number	**Stratum (from Forest Owner or Verifier)**	**Risk Class**	**Order of Random Selection**
13	Medium Dense Mature Riparian	Difficult Access	2
14	Medium Dense Mature Riparian	Difficult Access	1
17	Medium Dense Mature Riparian	Difficult Access	3

Planning and Implementing Field Verification Sampling: The selected stands shall be mapped and labeled with the random number to assist in developing a strategy to perform field sampling activities. Up to 6 plots or clusters may be re-measured in a stand (if plots are monumented) or installed (if plots are not monumented) in each stand. If the project area has not been stratified or there are less than 3 strata, the offset verifier shall locate the plots or clusters using a random process of their own design. For efficiency, it is acceptable for the offset verifier to relocate to a new area at the beginning of a day without having completed all the plots in the previous day.

Determination if the Stopping Rules have been met: The offset verifier must determine if the stopping rules have been met for each stratum after the measurement of each plot, unless the offset verifier determines it is appropriate to defer the determination until no later than the end of each day of sampling. The offset verifier must conduct the appropriate calculation for a paired or unpaired test. It is required that the offset verifier apply the random order selection in the sampling process. For efficiency purposes, the offset verifier may skip the random order on a temporal basis as long as the sequential analysis includes the ordered set of stands. This may provide significant efficiencies when selected stands and/or plots are in close geographic proximity and it is hypothesized that the stopping rules will require the full number of plots. An example is displayed in Table 10.3.

Table 10.3. The table displays a sampling schedule planned by the offset verifier and the verification results. In this example, the sequential sampling is conditionally satisfied

after Day 3 but requires the full set of randomly selected stands to be sampled up to the point of satisfying the sequential statistics, which is met after sampling Stand 3 on Day 4.

Stand	Stratum (from Forest Owner)	Risk Class	Order of Random Selection	Sampling Schedule (Planned)	Verification Effort	Verification Results
4	Dense Intermediate Conifers	High Stocking	1	Day 3	Day 1	Inconclusive. Stand 9 sampled. Sequential sampling criteria not satisfied - More plots are needed
9	Dense Intermediate Conifers	High Stocking	2	Day 1	Day 2	Inconclusive. Stand 15 sampled. Sequential sampling criteria not satisfied - More plots are needed
3	Dense Intermediate Conifers	High Stocking	3	Day 4	Day 3	Inconclusive. Stand 4 sampled. Sequential sampling criteria satisfied but stand order must be satisfied. Stand 3 must be sampled.
15	Dense Intermediate Conifers	High Stocking	4	Day 2	Day 4	Conclusive. Stand 3 sampled. Sequential sampling criteria is met and adherence to random selection is maintained
2	Dense Intermediate Conifers	High Stocking	5	Day 6		
10	Dense Intermediate Conifers	High Stocking	6	Day 5	Further Verification Effort not Necessary	
18	Dense Intermediate Conifers	High Stocking	7	Day 7		
8	Dense Intermediate Conifers	High Stocking	8	Day 8		

Paired Plots: The statistical test is based on a comparison of the offset verifier's measurements of plots within a selected stratum, calculated as CO_2-equivalent compared to the Offset Project Operator's or Authorized Project Designee's measurements of plots, which may include any adjustments for growth. The offset verifier must use α=0.05 and β=0.20 to control for error. The null hypothesis (H_0) is that the verification and project plots are equal.

1) Sample and measure at least the minimum number of plots required in Table 10.1.
2) If $n \geq ((Z_\alpha + Z_\beta)^2 \times S_n^2) / D^2$ then stop and evaluate. Otherwise take another sample.

n = Number of verification plots measured,
$Z_\alpha = \alpha/2\%\ N(0,1) = 1.645$,
$Z_\beta = \beta/2\%\ N(0,1) = 0.8416$,
S_n^2 = sample variance of the differences,
$D = \delta \times$ project average estimate.

3) If stopped, then evaluate.

   If $\bar{X}_N \leq K$ then accept H_0,
   If $\bar{X}_N > K$ then reject H_0.

   $\bar{X}_N$ = sample mean of the differences,
   N = total number of plots measured,

   $K = (Z_\alpha \times D) / (Z_\alpha + Z_\beta)$.

4) If H_0 was rejected then additional samples may be taken as long as the offset verifier is of the opinion that there is a chance that H_0 may be accepted based on the variability and trend observed.

Unpaired Plots: The statistical test is based on comparing the average CO_2-e estimates for each stratum from the verifier plots to the Offset Project Operator's or Authorized Project Designee's plots.

The offset verifier must use α=0.05 to control for error; the β is not specified because the method is constructing a confidence interval not a test. The null hypothesis (H_0) is that the verification and stratum averages are equal. The following procedure is appropriate for the unpaired test.

1) Sample and measure at least the minimum number of plots required in Table 10.1. Calculate n as the sum of the number of plots from both the stratum and the verification.
2) Calculate the following:

   $T_n = \bar{X}_P - \bar{X}_n$ where,
   $\bar{X}_P$ = stratum mean,
   $\bar{X}_n$ = verification mean after sample n.
   S_n^2 = sample variance of the verification plots,
   S_P^2 = sample variance of the stratum plots,
   D = δ × stratum average estimate.
   a = the percentile from a standard normal distribution for one half of alpha; is equal to 1.96 for α=0.05

3) If $n \geq (a^2/D^2) \times (S_n^2 + S_P^2)$ then stop and evaluate. (Note: $n = n = n_P + n_V$). Otherwise take another sample.
4) If stopped, then evaluate. Construct a confidence interval $T_n \pm D$.

   If the confidence interval includes zero then accept H_0,
   Otherwise reject H_0.

5) If H_0 was rejected then additional samples may be taken until as long as the verifier is of the opinion that there is a chance that H_0 may be accepted based on the variability and trend observed.

If the stopping rule in step (3) above cannot be attained within 100 plots then apply a standard unpaired t-test comparison using alpha of 0.05 and beta of 0.80.

3. Application of appropriate confidence deductions, if applicable.
4. Review reversal risk rating calculation.
5. Review of conformance with natural forest management and sustainable harvesting requirements.

10.2.3 Less-Intensive Verification

Less intensive verification refers to offset verification services that may be provided in interim years between full verifications. In the case of Forest Projects, full verification is required once every six years. Less intensive verification services may be provided in interim years between full verification at the discretion of the Offset Project Operator or Authorized Project Designee, subject to the concurrence of the accredited verification body that conducted the last full verification. Less intensive verification is not allowed if (1) there have been significant changes in methodologies or updates to the forest carbon inventory program, or (2) there has been a change in verification body since the previous verification.

Less intensive verification of an Offset Project Data Report only requires data checks and document reviews of an Offset Project Data Report based on the analysis and risk assessment in the most current sampling plan developed as part of the most recent full offset verification services. A site visit is not required. This level of verification may only be used if the verification team can provide findings with a reasonable level of assurance.

During less intensive verification of Forest Projects, the verification team must:

- Conduct data checks and carefully review data and calculations contained within the Offset Project Data Report, and
- At a minimum, review documentation supporting the data and calculations in the Offset Project Data Report, including the data used to update the forest carbon inventory and any new sample plot measurements, updates in growth and yield models, timber harvest plans and other regulatory documentation related to timber harvest, documentation of timber sales.

10.2.4 Verification of Multiple Reporting Years

If verification is less frequently than annual, the verification team must separately review and evaluate each reporting period of reported data specified in Section 9.2.2.

1. Each reporting period of quantified GHG reductions or GHG removal enhancements (QR_y) is separately evaluated for offset material misstatement.

10.2.5 Verification Team

Each verification team must include the following:

1. At least one Professional Forester that takes an active role in reviewing the forest carbon inventory program and conducting the site visit.
2. At least one individual with demonstrated competence in forest biometrics through:

a. A master's degree in statistics or forest biometrics, or another closely related science that includes 12 semester or 16 quarter hours of forest biometrics, sampling design and/or statistics coursework; or
b. University coursework that includes 12 semester or 16 quarter hours of forest biometrics, sampling design and/or statistics coursework, and at least two years of experience sampling, developing, implementing and analyzing forest biomass or carbon inventories

3. At least one individual with demonstrated knowledge of and competence in the use of forest growth and yield models, and demonstrated experience working with the model used in the forest carbon inventory being verified. Such experience should include university or other professional coursework, and/or project experience demonstrating competency in the use of the model.
4. An ARB-accredited Forest Offset Project Specialist.

An explanation demonstrating that the verification team includes individuals with the required experience and expertise must be included in the Notice of Verification Services submittal. The required experience and expertise may be demonstrated by a single individual, or by a combination of individuals.

10.2.6 Minimum Required Verification Schedule

Except as allowed for the second verification of Reforestation Projects, ARB requires that an ARB-accredited third-party verification body review and assess all reported data and information for a Forest Project and conduct a site visit at least once every six years. Verification is also required anytime new confidence deductions and/or reversal risk ratings are established. This requirement is consistent with Title 17, Cal. Code Regs. section 95977.1(b)(3)(D) and does not impose an additional visit requirement.

For Reforestation Projects, the second verification may be deferred up to 12 years at the discretion of the Offset Project Operator or Authorized Project Designee.

11 Glossary of Terms[8]

Above-Ground Live Biomass	The total mass of biomass in 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.
Additional	Additional is defined in the Regulation. Under this protocol, GHG reductions or removals from Forest Projects are demonstrated to be addition when they pass a legal requirement 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 that consists of common regulatory and political boundaries that affect forest management. The size of an Assessment Area 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 ARB's website.
Avoided Conversion Project	A type of Forest Project consisting of specific actions that prevent the conversion of privately owned forestland to a non-forest land use by

[8] For terms not defined in this section, the definitions in the Regulation apply.

	dedicating the land to continuous forest cover through a conservation easement or transfer to public ownership.
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.
Biological Emissions	For the purposes of the Forest Offset 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	Biomass is defined in the Regulation.
Bole	A trunk or main stem of a tree.
Broadcast Fertilization	A fertilizer application technique where fertilizer is spread across the soil surface.
Carbon Pool	A greenhouse gas reservoir.
Common Practice	The average stocks of the standing live 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 percent 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 Buffer Account	Forest Buffer Account is defined in the Regulation as a holding account for Forest Project ARB offset credits administered by ARB. It is used as a general insurance mechanism against unintentional reversals for all forest offset projects listed under a Compliance Offset

	Protocol.
Forest Management	The commercial or noncommercial growing and harvesting of forests.
Forest Owner	A Forest Owner is defined in the Regulation as the owner of any interest in the real (as opposed to personal) property involved in a forest offset project. Generally, a Forest Owner is the owner in fee of the real property involved in a forest offset 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 all entities or individuals with interest in the real property are collectively considered the Forest Owners, however, a single Forest Owner must be identified as the Offset Project Operator.
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.
Forestland	Land that supports, or can support, at least 10 percent tree canopy cover and that allows for management of one or more forest resources, including timber, fish and wildlife, biodiversity, water quality, recreation, aesthetics and other public benefits.
GHG Removal Enhancement	GHG removal enhancement is defined in the Regulation. GHG removal enhancements are calculated as gains in carbon stocks over time relative to a Forest Project's baseline.
Greenhouse Gas (GHG) Reservoir	Greenhouse Gas Reservoir is defined in the Regulation. For Forest Projects, GHG reservoirs may include above-ground or below-ground biomass or harvested wood products, among others.
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 an the Offset Project Operator or Authorized Project Designee is registered with ARB or an approved offset project registry, submits all required documentation for project listing in the Regulation and this protocol, and the project has been approved by ARB or an approved offset project

	registry 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.
Metric ton (MT) or "ton"	A common international measurement for the quantity of GHG emissions, equivalent to about 2204.6 pounds or 1.1023 short tons.
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 3.8.2.
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.
Onsite Carbon Stocks	Carbon Stock as defined in the Regulation means "the quantity of carbon contained in an identified GHG reservoir." For Forest Projects onsite carbon stocks include the carbon stocks in the required carbon pools indicated in Table A.1 within the Project Area.

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. For forest projects that occur in a jurisdiction that has professional forester licensing laws and regulations, a Professional Forester must be credentialed in that jurisdiction. Where a jurisdiction does not have a professional forester law or regulation, then a Professional Forester is defined as either having the Certified Forester credentials managed by the Society of American Foresters, or other valid professional forester license or credential approved by a government agency in a different jurisdiction.
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 municipality, county, state, or country.
Qualified Conservation Easement	A qualified conservation easement must explicitly refer to the requirements of the regulation and this protocol and 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.
Reforestation Project	A type of Forest Project involving the restoration of tree cover on land that currently has no, or minimal, tree cover.
Reversal	A reversal as defined in the Regulation. Under this protocol, a reversal is deemed to have occurred if the quantified GHG reductions and removal enhancements in a given year are negative and offset credits were issued to the Forest Project in any previous year, regardless of the cause of the decrease.
Secondary Effects	Unintended changes in carbon stocks, GHG emissions, or GHG removals caused by the Forest Project.
Significant Disturbance	Any natural impact that results in a loss of at least 20 percent of the above-ground live

	biomass that is not the result of intentional or grossly negligent acts of the Forest Owner.
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 a minimum diameter at 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 biomass. Live trees include the stem, branches, roots, and leaves or needles of all live biomass, regardless of species, with a minimum diameter at breast height of five inches and a minimum height of 15 feet.
Stocks (or Carbon Stocks)	The quantity of carbon contained in an identified GHG reservoir (or carbon pool).
Submitted	A Forest Project is "submitted" when all of the appropriate forms have been uploaded and submitted.
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 5 inches and a minimum height of 15 feet with no branches within 3 feet from the ground at maturity.
Unintentional Reversal	An unintentional reversal as defined in the Regulation 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.

Appendix A Developing an Inventory of Forest Project Carbon Stocks

Quantification Methodology

This appendix provides requirements for quantifying a Forest Project's forest carbon stocks. It explains how to identify the required 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 Forest 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 onsite carbon pools associated with a Forest Project.

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, including all the information required in Section 9.1.1.1. 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.

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

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 offset projects versus those are excluded depending on the project. It also shows how the value for the pool is determined.

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

Category	Carbon Pool	Improved Forest Management	Reforestation	Avoided Conversion	Determination of Value
Living biomass	Standing Live	Required	Required*	Required	Sampled in Project
	Shrubs and Herbaceous Understory	Excluded	Required	Excluded	Sampled in Project
Onsite dead biomass	Standing Dead	Required	Required	Required	Sampled in Project
Soil	Soil**	Required/ Excluded**	Required/ Excluded**	Required/ Excluded**	Sampled in project

* 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 offset project first seeks verification of GHG reductions and GHG removal enhancements.
** Soil carbon is not anticipated to change significantly as a result of most Forest Project activities. Soil carbon is excluded except when specified in Section 5.

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.

Each Offset Project Operator or Authorized Project Designee must develop and document a forest carbon inventory methodology. The inventory method must be capable of quantifying carbon stocks for required carbon pools to a high degree of accuracy. A complete inventory methodology must include:

1. A description of the Offset Project Boundary, including a list of all carbon pools included in the Offset Project Boundary.
2. For each carbon pool, include a detailed description of the inventory sampling methodology used to quantify that carbon pool, with references clearly documented. This documentation must include:
    a. Standard procedures for the collecting of field measurements. These procedures must be detailed enough so that any qualified forester would be able to accurately repeat the previous measurements. These procedures must include a description of the types of sample plots, location of plots, and frequency for updating or replacing sample plots as well as the forest carbon inventory as a whole;
    b. Standard procedures for where and how to measure parameters used in biomass calculations such as dbh and height (including for irregular trees), how to classify dead wood, and for any other aspects of sampling where a consistent method needs to be documented; and
    c. Stratification rules (pre and post sampling), if applicable, that include a map of vegetation strata, results of stratification (area by strata), tools for application

(such as GIS, aerial photos), and a discussion of how boundaries were determined.

3. Documentation of all analytic methods and biomass equations used to translate field measurements into volume or biomass carbon estimates;
4. A documented quality assurance / quality control (QA/QC) plan including procedures for internal review to ensure that standard operating procedures are being followed. The QA/QC plan must include procedures for assessing and ensuring the quality of collection, transfer and archiving of field data; procedures for data entry and analysis, and data maintenance and archiving; and any other relevant procedures to ensure quality and consistency in the collection and maintenance of data used to compile the offset project data reports.
5. Description of data management systems and processes, including the collection, storage and analysis of inventory related data analytical methods to translate field measurements into volume and/or biomass estimates.
6. A change log documenting any changes in the inventory methods or equations used to calculate carbon stocks.
7. Standard procedures for updating the forest carbon inventory, including documented procedures to account for:
    a. Harvest;
    b. Growth;
    c. Disturbance;
    d. Incorporating new inventory and plot data, and retiring older sample plots;
    e. Modeling, as allowed under Appendix B; and
    f. Application of appropriate confidence deduction.

Inventory methods and sampling procedures, once established, must be consistent over the life of the project. Any changes to inventory methods or calculations must be documented and justified in the change log.

Allometric Equations and Biomass/Carbon Mass Estimates

The equations in this appendix and in the Forest Offset Protocol Resources section of ARB's webpage must 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 standing dead tree (for non-sound trees) biomass must be computed in terms of cubic volume and subsequently converted to biomass/carbon mass estimates.

Sample Plots

Any plot data used for deriving the forest carbon inventory estimates 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.

Steps for Developing a Complete Forest Carbon Inventory

The steps that follow provide more detail on establishing and maintaining a complete inventory and estimating carbon stocks. Results must be summarized in a table when submitting required data in an Offset Project Data Report (see Section 9).

Step 1 – Developing Inventory Methodology and Sample Plots

The Offset Project Operator or Authorized Project Designee must develop and describe a methodology to sample for biomass or volume of all required carbon pools. If a pre-existing forest inventory is used to develop a forest 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. Temporary flagging of plot center, as is customary to allow for check cruising, is required to ensure ongoing inventory quality and allow for offset 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. All tree species within the Project Area must be measured regardless of the merchantability of the trees.

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

Carbon Pool	**Name of Requirement**	**Description of Requirement**
Standing Live Carbon Stocks (above-ground portion)	Diameter (breast height) Measurements	The minimum diameter (at breast height) must be stated in the methodology, and this minimum diameter must not be greater than 5 inches (inventory must include all trees 5 inches and greater in diameter). Height must be measured as required in appropriate biomass equations.
	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 ARB and the verification body.
Standing Live Carbon Stocks (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 tons per hectare. The use of a function other than that provided in the protocol will need to be approved by ARB and the verification body.
Herbaceous Understory	Sampling Methodology	The sampling methodology prepared by Brown, Shoch, Pearson, & Delaney (2004). Alternative methodologies need to be reviewed and approved by ARB and the verification body.
Standing Dead Trees	Diameter (breast height) and top Diameter Measurements	The minimum diameter (at breast height) must be stated in the methodology, and this diameter must not be greater than 5 inches. The minimum height of standing dead trees is 15’. The method must include how volume is derived where a total height does not exist (i.e. where the tree is broken).
	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.

Step 2 – Estimating Carbon in Live Trees from Sample Plots

Standing live tree carbon estimates are required for all offset projects. The standing live tree estimate includes carbon in all portions of the tree, including the bole, stump, bark, branches, leaves, and roots. The Offset Project Operator or Authorized Project Designee 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.

All biomass estimates must be converted to carbon estimates. 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 tons/kg to convert the mass to metric tons of carbon.

Approved biomass equations will be available in the Forest Offset Protocol Resources section of ARB's website.

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 Offset Project Operator or Authorized Project Designee must provide a sampling methodology for standing dead tree carbon as part of an overall sampling strategy (discussed in Step 1). Sound dead trees can be computed using the equations provided for standing live carbon in Step 2. 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 tons.

For those trees where volume is computed, the volume will need to be converted to biomass density by applying conversion factors based on decay class. The methodology developed must include a description of the calculation techniques used to determine biomass density by decay class. The estimate of biomass density must be computed in terms of metric tons of carbon on a per acre basis. The density factors by decay class from Harmon et al (2008) may be used to estimate density in standing dead carbon stocks.

Step 4– Estimate Carbon in Shrubs and Herbaceous Understory from Sample Plots

Any methodology developed for measuring carbon in shrubs must be reviewed during verification. 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 5 – Estimate of Carbon Tons 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). Use the soil sampling methodology prepared by Brown, Shoch, Pearson, & Delaney (2004).

Step 6 – Sum Carbon Pools

The metric tons 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 GHG removal enhancements, all numbers must be converted to metric tons of CO_2-equivalent by multiplying by 3.664.

Table A.3. Summarizing Carbon Pools and Calculating Total Carbon

Carbon Pool	Source	Gross CO_2-equivalent Tons per Acre
Step 2 Live Carbon Stocks	From sampling results of trees.	
Steps 3 Standing Dead Carbon Stocks	From sampling results of standing dead biomass.	
Step 4 Shrubs and Herbaceous Understory	From sampling results of shrubs and herbaceous understory.	
Step 5 Soil	From sampling results of soil.	
	Sum of CO_2-equivalent Tons from Required 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 GHG removal enhancements. To help ensure that estimates of GHG reductions and GHG removal enhancements are conservative, a confidence deduction must be applied each year 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, perform the following:

1. Compute the standard error of the inventory estimate (based on the carbon in all carbon pools included in the forest carbon inventory).
2. Multiply the standard error by 1.645.
3. Divide the result in (2) by the total inventory estimate and multiply by 100. This establishes the sampling error (expressed as a percentage of the mean inventory estimate from field sampling) for a 90 percent 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.4. 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 19.9%	(Sampling Error – 5.0%) to the nearest $1/10^{th}$ percentage
20% or greater	100%

The confidence deduction must be updated each time the offset project is subject to verification, but must remain unchanged between verifications. If increased sampling over time results in a lower confidence deduction at the time of verification, the lower deduction must be applied to inventory estimates in the most recent reporting period subject to verification at that time. ARB or registry offset credits may be issued in the most recent reporting period for any verified increase in quantified GHG reductions and GHG removal enhancements associated with the new (lower) confidence deduction. Conversely, if a loss of qualified sampling plots results in a higher confidence deduction, this higher deduction is applied to the inventory estimates in the most recent reporting period subject to verification at that time. Any resulting decrease in quantified GHG reductions and GHG removal enhancements from prior years as a result of the increased confidence deduction will be treated as an intentional reversal, and must be compensated pursuant to the Regulation.

Appendix B Modeling Carbon Stocks

Quantification Methodology

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:

- 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

Inventory plot data may be updated 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.

Additional models will be allowed following approval of a state forestry authority (i.e. a state agency responsible for 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 in 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 reviewed at least every 10 years

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 tons in the y-axis. Baseline carbon stocks must be projected forward from the date of the Forest Project's offset project commencement. 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 tons and carbon tons 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

Quantification Methodology

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, GHG reductions and GHG removal enhancements must be effectively "permanent," meaning that sequestered carbon associated with GHG reductions and removals must remain stored for at least 100 years. 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.

Because of the significant uncertainties associated with predicting wood product carbon storage over 100 years, the accounting requirements in this appendix are designed to err on the side of conservativeness. This means the calculations are designed to reduce the risk of overestimating the GHG reductions and GHG removal enhancements achieved by a Forest Project. One of the largest sources of uncertainty is predicting the amount of wood product carbon likely to be stored in landfills. To accommodate this uncertainty, and ensure that Forest Project GHG reductions and GHG removal enhancements are accounted for conservatively:

1. Landfill carbon storage is *excluded* from calculations of wood-product carbon in years where a Forest Project's actual harvesting volumes exceed estimated baseline harvesting volumes, as determined in Section 6.
2. Landfill carbon storage is *included* in calculations of wood-product carbon in years where a Forest Project's actual harvesting volumes are below estimated baseline harvesting volumes, as determined in Section 6.

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 (when applicable).
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 (actual or baseline) that will be delivered to mills, by volume (cubic feet) or by green weight (lbs.), and by species for the current year (y). In all cases, harvested wood volumes and/or weights must exclude bark.

   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, documentation must be provided 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).[9] 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 2,204.6 pounds/metric ton to convert to metric tons 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 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 tons of carbon) derived in C.1 by the mill efficiency identified for the project's Assessment Area in the Forest Offset Protocol Resources section of ARB's website. 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

[9] The Wood Handbook (USFS, 2010) contains specific gravities for tree species in other regions. Multiply the specific gravity by the density of water (62.43 lbs/ft^3) to get wood density.

decomposition of harvested wood over time, a decay rate is applied to wood products according to their product class. To 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
2. If a verified report cannot be obtained, looking up default wood product classes for the project's Assessment Area, as given in the most current Assessment Area Data File found on the Forest Offset Protocol Resources section of ARB's website.

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 tons).

Equation C.1. Average Carbon Stored in In-Use Wood Products

$$WP_{in\text{-}use,\,y} = \sum(\text{Table C.2, Row 4}) \times 3.67$$

Where,

$WP_{in\text{-}use,\,y}$	=	Average carbon stored in in-use wood products over 100 years from wood harvested in year y (actual or baseline)

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 tons C in each class	(3A)	(3B)	(3C)	(3D)	(3E)	(3F)	(3G)
100-year average storage factor (in-use)	0.463	0.250	0.484	0.582	0.380	0.176	0.058
Average C stored in in-use wood products (metric tons)	(4A)	(4B)	(4C)	(4D)	(4E)	(4F)	(4G)

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

Wood product carbon in landfills is only calculated for years in which a Forest Project's actual harvesting volumes are below estimated baseline harvesting levels, as determined in Section 6. To determine the appropriate value for average landfill carbon storage, perform the following steps:

Step 1 – 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 tons C in each class	(3A)	(3B)	(3C)	(3D)	(3E)	(3F)	(3G)
100-year average storage factor (landfills)	0.298	0.414	0.287	0.233	0.344	0.454	0.178
Average C stored in landfills (metric tons)	(4A)	(4B)	(4C)	(4D)	(4E)	(4F)	(4G)

Step 2 – Determine the appropriate value to use for wood product carbon in landfills

Use Equation C.2. Average Wood Product Carbon Stored in Landfills to determine the appropriate value for the average wood product carbon stored in landfills over 100 years (in units of CO_2-equivalent metric tons).

Equation C.2. Average Wood Product Carbon Stored in Landfills

$$If \sum_{n=1}^{y}(AC_{hv,n} - BC_{hv,n}) < 0, then\, WP_{landfill,y} = \sum(Table\text{ C.3}, Row\, 4) \times 3.67$$

$$If \sum_{n=1}^{y}(AC_{hv,n} - BC_{hv,n}) > 0, then\;\; WP_{landfill,y} = 0$$

Where,

$WP_{\mathbf{landfill,\,y}}$	=	Average carbon stored in wood products in landfills over 100 years from wood harvested in the current year/reporting period (actual or baseline)
$AC_{hv,\,n}$	=	Actual amount of onsite carbon harvested in reporting period n (prior to delivery to a mill), expressed in CO_2-equivalent tons
$BC_{hv,\,n}$	=	Estimated average baseline amount of onsite carbon harvested in reporting period n (prior to delivery to a mill), expressed in CO_2-equivalent tons
y	=	The current year or reporting period

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.3). 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.3.

$$WP_{total,\ y} = WP_{in\text{-}use,\ y} + WP_{landfill,\ y}$$

Where,

$WP_{total,\ y}$	=	Average carbon stored over 100 years from wood harvested in year y (actual or baseline)
$WP_{in\text{-}use,\ y}$	=	Average carbon stored in in-use wood products over 100 years from wood harvested in year y (actual or baseline)
$WP_{landfill,\ y}$	=	Average carbon stored in wood products in landfills over 100 years from wood harvested in year y (actual or baseline)

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

A reversal risk rating must be determined for the 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 Forest Project undergoes a verification site visit. Therefore, a Forest Project's risk profile and its assessment are dynamic. If estimated risk values and associated mitigation measures are updated as improvements in quantifying risks or changes in risks are determined, any adjustments to the risk ratings will affect only current and future year contributions to the Forest Buffer Account.

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	Default Risk
	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. Forest Projects that employ a Qualified Conservation Easement, or that occur on public lands, have lower risk.

Table D.2. Financial Risk Identification

Applies to all projects		
Identification of Risk	**Contribution to Reversal Risk Rating**	
Default Financial Risk	**Forest Project not on public lands or without a Qualified Conservation Easement**	**Forest Project on public lands or with a Qualified Conservation Easement**
	5%	1%

D.2 Management Risk

Management failure is the risk of management activities that directly or indirectly could lead to a reversal. Forest Projects that occur on public lands, or employ a Qualified Conservation Easement 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	**Contribution to Reversal Risk Rating**
United States Default Harvesting Risk	0%

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	**Contribution to Reversal Risk Rating**
With Qualified Conservation Easement that explicitly encumbers all development rights	0%
Without Qualified Conservation Easement	2%

Management Risk III – Over-Harvesting

Favorable timber values, among other reasons, may motivate an Offset Project Operator or Authorized Project Designee to realize timber values at the expense of managing carbon stocks for which ARB or registry offset credits have been issued. 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	**Contribution to Reversal Risk Rating**
With Qualified Conservation Easement that explicitly encumbers timber harvesting associated with project stocks	0%
Without Qualified Conservation Easement	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	**Contribution to Reversal Risk Rating**
United States Default Social Risk	2%

D.4 Natural Disturbance Risk

Natural disturbances can pose a significant risk to the permanence of the GHG reductions and GHG removal enhancements. 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	**Contribution to Reversal Risk Rating**
United States Default Fire Risk	4%
If fuel treatments have been implemented for the Project Area, reduce the value above by the appropriate Y% as indicated below.*	(4%) x Y%

* 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	**Contribution to Reversal Risk Rating**
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	**Contribution to Reversal Risk Rating**
Default Risk Contribution from Other Catastrophic Events	3%

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

Use table D.10 to summarize the Forest Project's reversal risk rating. As indicated above, projects that employ a Qualified Conservation Easement, or that occur on public lands, are exempt from certain risk categories. Such Qualified Conservation Easements 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 Account Based on Risk.

Risk Category	**Contribution from Risk Descriptions Above**		
	Source	Forest Project without a Qualified Conservation Easement and/or Public Ownership	Forest Projects with a Qualified Conservation Easement and/or Public Ownership
Financial Failure	Default Risk	5%	1%
Illegal Forest Biomass Removal	Default Risk	0%	0%
Conversion	Default Risk	2%	0%
Over-Harvesting	Default Risk	2%	0%
Social	Default Risk	2%	2%
Wildfire	Calculated Risk from worksheet	X%	X%
Disease or Insect Outbreak	Calculated Risk from worksheet	3%	3%
Other Catastrophic Events	Calculated Risk from worksheet	3%	3%

Completing the Risk Rating Analysis:

The Forest 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 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 the criteria in Table E.1.

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

1. Identify whether site preparation costs[10] 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 percent or more of the Project Area; or
        ii. Soil ripping has occurred on more than 50 percent 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 the Forest Offset Protocol Resources section of ARB's website.
3. Identify the standard Rotation Age for the project's Assessment Area, from the lookup table in the Forest Offset Protocol Resources section of ARB's website.
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. 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 Forest 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.

[10] All Forest 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 (Length)	Site Class	Eligibility	Scenario #
High Site Preparation	High	Short, Medium, Long	Higher	Not Eligible	1
			Lower	Not Eligible	2
		Extremely Long	Higher	Eligible	3
			Lower	Eligible	4
	Medium	Short, Medium	Higher	Not Eligible	5
			Lower	Not Eligible	6
		Long	Higher	Not Eligible	7
			Lower	Eligible	8
		Extremely Long	Higher	Eligible	9
			Lower	Eligible	10
	Low	Short	Higher	Not Eligible	11
			Lower	Eligible	12
		Medium, Long, Extremely Long	Higher	Eligible	13
			Lower	Eligible	14
	Very Low	Short, Medium, Long, Extremely Long	Higher	Eligible	15
			Lower	Eligible	16
Low Site Preparation	High	Short, Medium	Higher	Not Eligible	17
			Lower	Not Eligible	18
		Long, Extremely Long	Higher	Not Eligible	19
			Lower	Eligible	20
	Medium	Short, Medium	Higher	Not Eligible	21
			Lower	Not Eligible	22
		Long	Higher	Not Eligible	23
			Lower	Eligible	24
		Extremely Long	Higher	Eligible	25
			Lower	Eligible	26
	Low	Short	Higher	Not Eligible	27
			Lower	Not Eligible	28
		Medium	Higher	Not Eligible	29
			Lower	Eligible	30
		Long, Extremely Long	Higher	Eligible	31
			Lower	Eligible	32
	Very Low	Medium, Long, Extremely Long	Higher	Eligible	33
			Lower	Eligible	34
		Short	Higher	Not Eligible	35
			Lower	Not Eligible	36

Appendix F Determining a Value for Common Practice

Quantification Methodology

Forest Assessment Areas Introduction
Assessment areas are used to provide standardized regional data for offset project development. An assessment area is generally defined as a forest vegetation community that shares common environmental, economical, and regulatory attributes. The Forest Offset Protocol Resources section of ARB's website provides data, by assessment area, necessary to calibrate and/or implement project accounting, including:

- Common Practice – The average carbon stocks (metric tons) of the above ground portion of live trees on private lands. The average carbon stock is the result of the suite of management activities within the assessment area. The common practice value is the extent to which improved forest management projects can receive credit for avoided emissions. (See Section 6.2.)
- Diversity Index – The maximum amount (by carbon percentage) of any one native species allowed within a project. (See Section 3.8.2.)
- The rotation length commonly used in the assessment area and the value of harvest for incorporating in a financial test for reforestation projects (see Appendix E).
- The mill efficiency used for calculating wood products (see Appendix C).
- The wood product classes generated for calculating wood products values (see Appendix C).

Defining Assessment Areas

The U.S. Forest Service Forest Inventory and Analysis Program (FIA) is the basis for development of assessment areas. The FIA program collects data on U.S. forests using an extensive array of coordinated sample plots throughout the nation. Together the plots comprise a national inventory system designed to assess the state of U.S. forests on an ongoing basis. The hierarchical and spatial nature of FIA data make it possible to group sample field plots by geographical location. FIA plots are assigned an attribute referred to as 'forest type' that identifies the dominant vegetation present at the plot. Forest Types were combined into forest communities following a process described further below. An assessment area is a forest community within a defined geographical unit. The geographical units are discussed below.

Ecosections are spatial units and can be mapped. The geographical units that contain assessment areas are based on individual ecosections or combined ecosections (called supersections). Supersections were created in order to stratify the plots into high site class and low site class (where possible) and to increase the statistical reliability of the common practice estimates derived for each assessment area. The combination of ecosections into supersections only occurred where adjacent ecosections share similar environmental, economic, and regulatory attributes. Ecosections are combined into supersections if:

1. The ecosections are adjacent to each other.
2. They share a similar distribution of plots by forest types, which indicates that the ecosections share similar climate, elevation, and other environmental variables.
3. The economics of forest management are similar between the ecosections. The criteria considered to determine economic commonality between ecosections include forest product

generation, transportation networks, forest product mill types, and wood products markets. This was based on professional knowledge of regional timber markets.

4. Regulations between ecosections are relatively homogeneous across ecosection boundaries. Ecosections are not combined into supersections in cases where forest practice regulations between adjoining administrative units are known to be markedly different.

The Forest Service computed the statistics for the combined forest types aggregated at the supersection level and disaggregated at the ecosection level. The statistics are reported on a per acre basis and include board foot volume, basal area (square feet), above ground carbon tons, and the sampling error. Ecosections were not combined into supersections if the aggregation changed average standing carbon stocks of any assessment areas by more than 10%, indicating that there are environmental, economic or regulatory differences affecting the forest stocks within these communities.

The aggregation of forest types into forest communities that define assessment areas is based on the natural forest communities found within the ecosections rather than the presence of a single dominant species as in plantation management. As an example, the Northwest Coast Range contains many forest holdings of intensively managed Douglas-fir forests, yet the natural forest community contains many other species such as western hemlock, Sitka spruce, and red alder, among others. The plots used to define the assessment area, as well as the common practice statistic, are the entire set of plots found in the natural forest community. No effort is made to isolate assessment areas based on the existence of plantations. Successional stage, including the presence of shade tolerance species, and management influence on species prevalence is not a basis for stratifying distinct communities. The Forest Offset Protocol Resources data on ARB's webpage displays the associations of forest species (forest types) and assessment areas for all of the ecosections and supersections. Figure F.1 summarizes conceptually the methodology for delineating assessment areas.

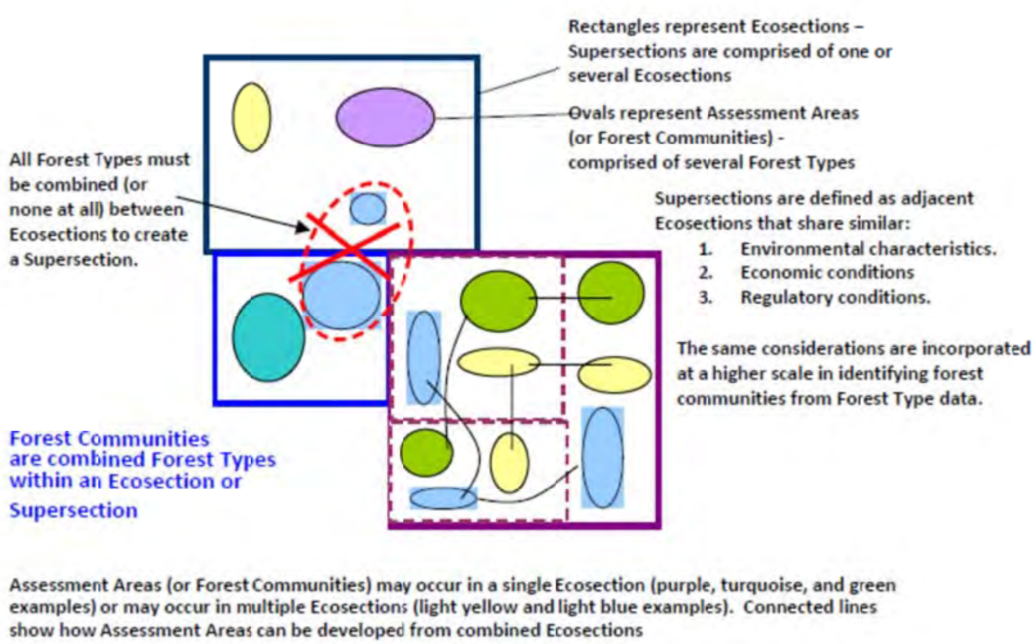


Figure F.1 Schematic of Process to Define Assessment Areas

Determining a Value for Common Practice

The following requirements and methods provide step by step instructions for determining the appropriate Common Practice value for an Improved Forest Management project based on its geographic location and boundaries.

1. **Determine the Geographic Ecosection(s) or Supersection(s) Within Which the Project Area is Located**
   The Offset Project Operator or Authorized Project Designee must determine the geographic Ecosection(s) or Supersection within which the Project Area is located by consulting maps of Supersections. These maps can be downloaded from the Forest Offset Protocol Resources section of ARB's website in either a .pdf format or a Geographical Information System (GIS) shapefile.

2. **Determine the Acreage of the Project Area That Falls Within Each Assessment Area Contained in the Ecosection(s) or Supersection(s)**

   Ecosections and Supersections may consist of one or many Assessment Areas. Assessment Areas are groupings of tree species that are commonly found in association with each other, as in a vegetation community. Assessment Areas are not mapped since the geographic locations of forest communities vary based on highly resolute environmental variables. To determine which Assessment Areas are included within the Project Area, compare the tree species in the Project Area to the species list associated with each Assessment Area in the project's Ecosection(s) or Supersection(s) (identified in Step 1). Tree species information must be looked up using the most current Assessment Area Data File from the Forest Offset Protocol Resources section of ARB's website. The minimum mapping resolution for vegetation communities is 20 acres. Therefore, any contiguous area 20 acres or greater within the Project Area that consists of a separate vegetation community must be independently mapped.

3. **Where Necessary, Stratify Project Area Acres According to Whether They Are High or Low Site Class**

   The Assessment Area Data File on the Forest Offset Protocol Resources section of ARB's website provides data for each Assessment Area by high, low, or all site classes. For Assessment Areas where data are attributed for high and low site classes, the Offset Project Operator or Authorized Project Designee must further stratify the Project Area and identify the acreage that falls within each site class.

   The computation of the statistics in the Assessment Area Data File (on a per acre basis) for board foot volume, basal area (square feet), and CO_2 equivalent was done for high and low site classes wherever the FIA plots were available in adequate quantity to achieve a sampling error of 18 percent or less. The board foot volume and basal area statistics are presented only to elucidate comparisons to the Common Practice (CO_2 equivalent) statistic. Board foot volume and basal area statistics are not used for other purposes in the protocol.

   For stratification purposes, a "high" site class means a Timber Site I or II (Forest Service Types I, II, and III). A low site class means a Timber Site III, IV, or V (Forest Service Types IV – VII). Landowners must determine the portion of the Project Area that is in each site class for each Assessment Area using soils data from a state or federal agency, direct site class data from a state or federal agency, attestation from a state forester, or through field analysis. Whatever method is used, documentation of the analysis must be provided to the verifier at the project's initial verification.

4. **Identify the Common Practice Statistic Associated with Each Assessment Area and Site Class Stratum**

   For each Assessment Area and Site Class within the Project Area, identify the appropriate Common Practice statistic from Assessment Area Data File. The value displayed in the Assessment Area Data File indicates CO_2 equivalent metric tons per acre in the above ground portion (bole, bark, top and branches) of live trees.

   If data for an Assessment Area are provided for both high and low site classes, and a Offset Project Operator or Authorized Project Designee is unable or unwilling to stratify the Project Area into site classes using an acceptable method described above, then the high site-class Common Practice statistic must be used for all acres within the Assessment Area.

5. **Determine a Value for Common Practice for the Entire Project Area**

   Determine a single Common Practice value for the entire Project Area by calculating the average of the Common Practice statistics for each Assessment Area and site class, weighted by the number of acres of each Assessment Area and site class within the Project Area. See Table F1 for an example.

Table F1. Example of Common Practice Statistic Calculation

Ecosection(s) /Supersection(s)	Assessment Area	Site Class	Acres	Common Practice (Metric Tons CO2-e)
Name the Ecosection(s)/Supersection(s) the project is found within.	*Identify the Assessment Areas the project is in. If the project is in more than one site class for an Assessment Area, enter the Assessment Area twice*	*Enter the Site Class Value*	*Acres for each Assessment Area-Site Class Combination*	*Enter the Value from the most current Assessment Area Data File*
Adirondacks & Green Mountains	Adirondacks & Green Mountains Northeast Conifers	High	1,000	91.8
Adirondacks & Green Mountains	Adirondacks & Green Mountains Northeast Conifers	Low	100	84.4
Adirondacks & Green Mountains	Adirondacks & Green Mountains Northern Hardwood	High	50	102.8
Total Acres / Weighted Average Common Practice			**1,150**	**91.6**

CAPCOA GHG Rx Forestry Protocol #2:

100-year Improved Forest Management Methodology for Quantifying GHG Removals and Emission Reductions through Increased Forest Carbon Sequestration

(Based on Improved Forest Management protocol developed by American Carbon Registry)

(Approved by the CAPCOA Board on May 1, 2013)

The following conditions apply for use in the CAPCOA GHG Rx:

1. The protocol allows projects to be located in any privately owned forest land in the United States of America. Only GHG emission reductions developed from projects within California are eligible for listing in the CAPCOA GHG Rx;

2. Projects occurring after 1/1/07 are eligible unless the reductions are associated with San Joaquin Valley APCD Rule 2301 and a project start date of 1/1/05 may apply;

3. The protocol may not be applicable to projects that CAPCOA determines are common practice.

American Carbon Registry®
Trusted solutions for the carbon market

100-year Improved Forest Management Methodology for Quantifying GHG Removals and Emission Reductions through Increased Forest Carbon Sequestration on U.S. Timberlands

July 2011

Methodology developed by Finite Carbon Corporation

FiniteCarbon
Connecting Forestry and Carbon Finance

A nonprofit enterprise of
Winrock International

CONTENTS

A. METHODOLOGY DESCRIPTION

A1. SCOPE AND DEFINITIONS

This methodology is designed to quantify GHG emission reductions resulting from forest carbon projects that reduce emissions by exceeding baseline forest management practices. Removals are quantified for increased sequestration through retention of annual forest growth when project activities exceed the baseline.

Baseline determination is project-specific and must describe the harvesting scenario that would maximize net present value (NPV) of perpetual wood products harvests.

Project proponents must demonstrate there is no activity-shifting leakage above the *de minimis* threshold. Market leakage must be assessed and accounted for in the quantification of net project benefits.

Definitions and Acronyms

ACR	American Carbon Registry
ATF	American Tree Farm
Activity Shifting Leakage	Increases in harvest levels on non-project lands owned or under management control of the project area timber rights owner
Baseline	Management scenario in the absence of project activities
Carrying Costs	Property taxes, mortgage interest, and insurance premiums
Crediting period	The period of time in which the baseline is considered to be valid and project activities are eligible to generate ERTs
de minimis	Threshold of 3% of the final calculation of emission reductions or removals
ERT	Emission Reduction Ton
Ex-ante	Prior to project certification
FSC	Forest Stewardship Council
Forestland	Forest land is defined as land at least 10 percent stocked by trees of any size, and not currently developed for non-forest uses

IPCC	Intergovernmental Panel on Climate Change
Minimum Project Term	Time Period which project activities must be maintained and monitored through third-party verification
Native Species	Trees listed as native to a particular region by the Native Plant Society, SAF Forestry Handbook, or State adopted list
Net Present Value (NPV)	The difference between the present value of cash inflows and the present value of cash outflows over the life of the project
SFI	Sustainable Forestry Initiative
Timberlands	Forestlands managed for commercial timber production
Tree	A perennial woody plant with a diameter at breast height (1.37 m) >5 cm and a height of greater than 1.3 m
Ton	A unit of mass equal to 1000 kg
Unmanaged stands	Areas greater than 20 acres in size demonstrating mature stand characteristics that have not been subjected to timber harvesting activities within the last 50 years
VCS	Verified Carbon Standard

A2. APPLICABILITY CONDITIONS

- Methodology is applicable only on privately owned forestland within the US
- The methodology applies to lands subject to commercial timber harvesting activities held by entities owning or controlling timber rights on greater than 1,000 acres of forestland managed under an existing commercial timber harvesting program. Documentation of an existing commercial timber program must be provided (see Section B1)
- Forests must be certified by FSC, SFI, or ATF or become certified within one year of the project start date
- Use of non-native species is prohibited where adequately stocked native stands were converted for forestry or other land uses after 1997
- Draining or flooding of wetlands is prohibited
- The project must demonstrate an increase in on-site stocking levels above the baseline condition for the entire crediting period

- There may be no leakage above *de minimis* levels through activity shifting to other lands owned, or under management control, by the timber rights owner outside the scope of the carbon project

A3. POOLS AND SOURCES

Carbon pools	Included / Optional / Excluded	Justification / Explanation of choice
Above-ground biomass carbon	Included	Major carbon pool subjected to the project activity
Below-ground biomass carbon	Included	Major carbon pool subjected to the project activity
Harvested wood products	Included	Major carbon pool subjected to the project activity
Standing dead wood	Included/Optional	Major carbon pool in unmanaged stands subjected to the project activity. Project proponents may also elect to include the pool in managed stands (where included, the pool must be estimated in both the baseline and with project cases).
Lying dead wood	Optional	Project proponents may elect to include the pool (where included, the pool must be estimated in both the baseline and with project cases)
Litter / forest floor	Excluded	Changes in the litter pool are considered *de minimis* as a result of project implementation
Soil carbon	Excluded	Changes in the soil carbon pool are considered *de minimis* as a result of project implementation

Emission Source	Gas	Included / excluded	Justification / Explanation of choice
Burning of biomass	CO_2	Excluded	However, carbon stock decreases due to burning are accounted as a carbon stock change
	CH_4	Included	Non-CO_2 gas emitted from biomass burning

	N_2O	Excluded	Potential emissions are negligibly small

Leakage Source		Included / Optional / Excluded	Justification / Explanation of choice
Activity Shifting	Timber Harvesting	Excluded	Project proponent must demonstrate no activity-shifting leakage beyond the *de minimis* threshold will occur as a result of project implementation
	Crops	Excluded	Forestlands eligible for this methodology do not produce agricultural crops that could cause activity shifting
	Livestock	Excluded	Forestlands eligible for this methodology do not contain livestock that could cause activity shifting
Market Effects	Timber	Included	Reductions in product outputs due to project activity may be compensated by other entities in the marketplace. Those emissions must be included in the quantification of project benefits.

B. ELIGIBILITY, BOUNDARIES, ADDITIONALITY, AND PERMANENCE

B1. PROJECT ELIGIBILITY

This methodology applies to privately owned timberlands in the US able to document 1) clear land title or timber rights and 2) offsets title. Projects must also meet all other requirements of the American Carbon Registry Program.

The methodology applies to lands subject to commercial timber harvesting activities held by entities owning or controlling timber rights on greater than 1,000 acres of forestland under an existing commercial timber harvesting program. Evidence of an existing and on-going commercial timber harvesting program must be provided. Documented evidence must include records from recent timber sales conducted by the entity within the previous 10-year period, long-term timber management plans prepared by forestry professionals, or other work plans for forest management activities conducted with the primary objective to engage in timber sale activities.

Proponents must use the U.S. Forest Service Forest Inventory & Analysis Program definition to demonstrate the project area meets the definition of Forestland conditions. Forestland is defined as land at least 10 percent stocked by forest trees of any size, and not currently developed for non-forest uses.

B2. PROJECT GEOGRAPHIC BOUNDARY

The project proponent must provide a detailed description of the geographic boundary of project activities. Note that the project activity may contain more than one discrete area of land, that each area must have a unique geographical identification, and that each area must meet the eligibility requirements. Information to delineate the project boundary must include:

- Project area delineated on USGS topographic map
- General location map
- Property parcel map

Aggregation of forest properties with multiple landowners is permitted under the methodology with aggregated areas treated as a single project area; however, each ownership within an aggregated project must meet the applicability and eligibility requirements of the methodology.

B3. PROJECT TEMPORAL BOUNDARY

Projects with a start date of November 1, 1997 or later are eligible[1]. The start date is when the project proponent began to apply the land management regime to increase carbon stocks and/or reduce emissions.

In accordance with the American Carbon Registry's Forest Carbon Project Standard v2.0, all projects will have a crediting period of twenty (20) years. Crediting periods may be renewed, without limitation, by complying with all then-current ACR requirements, re-evaluating the baseline scenario, and using emission factors, tools and methodologies in effect at the time of renewal.

Under this methodology the Project Proponent commits to monitoring for a minimum term of one hundred (100) years after the last year of ERT issuance.[2]

If the project start date is more than one year before submission of the GHG plan, the project proponent shall provide evidence that GHG mitigation was seriously considered in the decision to proceed with the project activity. Evidence shall be based on official, legal and/or other corporate documentation. Early actors undertaking voluntary activities to increase forest carbon sequestration prior to the release of this requirement may submit as evidence recorded conservation easements or other deed restrictions that affect onsite carbon stocks.

B4. ADDITIONALITY

Projects must apply a three-prong additionality test[3] to demonstrate that they exceed currently effective and enforced laws and regulations; exceed common practice in the forestry sector and geographic region; and face a financial implementation barrier.

The regulatory surplus test involves existing laws, regulations, statutes, legal rulings, or other regulatory frameworks that directly or indirectly affect GHG emissions associated with a project action or its baseline candidates, and which require technical, performance, or management actions. Voluntary guidelines are not considered in the regulatory surplus test.

The common practice test requires project proponents to evaluate the predominant forest industry technologies and practices in the project's geographic region. The Project Proponent shall demonstrate that the proposed project activity exceeds the common practice of similar landowners managing similar forests in the region. Projects initially deemed to go beyond common practice are considered to meet the requirement for the duration of their crediting period. If common practice adoption rates of a particular practice change during the crediting period, this may make the project non-additional and thus ineligible for renewal, but does not affect its additionality during the current crediting period.

[1] American Carbon Registry (2010), *American Carbon Registry Forest Carbon Project Standard, version 2.1.* Winrock International, Little Rock, Arkansas.
[2] This requirement overrides the minimum project term requirement of the Forest Carbon Project Standard *for projects registered under this methodology only.*
[3] Ibid.

An implementation barrier represents any factor or consideration that would prevent the adoption of the practice/activity proposed by the Project Proponent. Financial barriers can include high costs, limited access to capital, or an internal rate of return in the absence of carbon revenues that is lower than the Proponent's established minimum acceptable rate. Financial barriers can also include high risks such as unproven technologies or business models, poor credit rating of project partners, and project failure risk. When applying the financial implementation barrier test, project proponents should include solid quantitative evidence such as NPV and IRR calculations. The project must face capital constraints that carbon revenues can potentially address; *or* carbon funding is reasonably expected to incentivize the project's implementation; *or* carbon revenues must be a key element to maintaining the project action's ongoing economic viability after its implementation[4].

B5. PERMANENCE

Project proponents using this methodology commit to monitoring for a minimum term of 100 years after the last year of ERT issuance. Projects must have effective risk mitigation measures in place to compensate fully for any loss of sequestered carbon whether this occurs through an unforeseen natural disturbance or through a project proponent or landowner's choice to discontinue forest carbon project activities. Such mitigation measures can include contributions to the buffer pool or use of another ACR-approved risk mitigation product. Effective and complete mitigation of losses, rather than the minimum project term, provides permanence.

To assess the risk of reversal, project proponents must conduct a risk assessment addressing both general and project-specific risk factors. General risk factors include risks such as financial failure, technical failure, management failure, rising land opportunity costs, regulatory and social instability, and natural disturbances. Project-specific risk factors vary by project type can include land tenure, technical capability and experience of the project developer, fire potential, risks of insect/disease, flooding and extreme weather events, illegal logging potential, and others.

Project proponents must conduct their risk assessment using the *ACR Tool for Risk Analysis and Buffer Determination or* the *VCS Tool for AFOLU Non-Permanence Risk Analysis and Buffer Determination.* The output of either tool is an overall risk category, expressed as a fraction, for the project translating into the buffer deduction that must be applied in the calculation of net ERTs (section G1). This deduction must be applied unless the project proponent uses an ACR approved insurance product or other program-approved mitigation mechanism.

[4] American Carbon Registry (2010), *American Carbon Registry Forest Carbon Project Standard, version 2.1.* Winrock International, Little Rock, Arkansas.

C. BASELINE

C1. IDENTIFICATION OF BASELINE

The IFM baseline is the legally permissible harvest scenario that would maximize net present value (NPV) of *perpetual* wood products harvests. The baseline management scenario shall be based on silvicutural prescriptions recommended by published state or federal agencies to perpetuate existing on-site timber producing species while fully utilizing available growing space. The resulting harvest schedule is used to establish baseline stocking levels through the crediting period.

Required inputs for the NPV calculation include the results of a recent timber inventory of the project lands, prices for wood products of grades that the project would produce, costs of logging, reforestation and related costs, silvicultural treatment costs, and carrying costs. Project proponents shall include roading and harvesting costs as appropriate to the terrain and unit size. Project proponents must model growth of forest stands through the crediting period. Project proponents should use an optimization program that calculates the maximum net present value for the harvesting schedule. The discount rate for modeling shall be 6% per year, in real (without inflation) terms. Wood products must be accounted.

Consideration shall be given to a reasonable range of feasible baseline assumptions and the selected assumptions should be plausible for the duration of the baseline application.

The ISO 14064-2 principle of conservativeness must be applied for the determination of the baseline scenario. In particular, the conservativeness of the baseline is established with reference to the choice of assumptions, parameters, data sources and key factors so that project emission reductions and removals are more likely to be under-estimated rather than over-estimated, and that reliable results are maintained over a range of probable assumptions. However, using the conservativeness principle does not always imply the use of the “most” conservative choice of assumptions or methodologies[5].

C 1.1 Confidentiality of Proprietary Information

While it remains in the interest of the general public for project proponents to be as transparent as possible regarding GHG reduction projects, the project proponent may choose at their own option to designate any information regarded as confidential due to proprietary considerations. If the project proponent chooses to identify information related to financial performance as confidential, the project proponent must submit the confidential baseline and project documentation in a separate file marked “Confidential” to the GHG Program and this information shall not be made available to the public. The GHG Program authorities and verification body shall utilize this information only to the extent required to register the ERTs. If the project proponent chooses to keep financial information confidential, a publically available project summary must be prepared and provided to the GHG Program.

[5] ISO 14064-2:2006(E)

C2. BASELINE STRATIFICATION

If the project activity area is not homogeneous, stratification must be carried out to improve the precision of carbon stock estimates. Different stratifications may be required for the baseline and project scenarios in order to achieve optimal accuracy and precision of the estimates of net GHG emissions reductions or GHG removal by sinks. For estimation of baseline carbon stocks, strata must be defined on the basis of parameters that are key variables for estimating changes in managed forest carbon stocks, for example:

a. Management regime
b. Species or cover types
c. Size and density class
d. Site class

C3. BASELINE NET REDUCTIONS AND REMOVALS

Baseline carbon stock change must be calculated for the entire crediting period. The baseline stocking level used for the stock change calculation is derived from the baseline management scenario developed in section C1. This methodology requires annual baseline stocking levels to be projected for the entire crediting period and a long-term average baseline stocking level be calculated for the crediting period.

Annual projected stocking levels are used for the baseline stock change calculation until the projected stocking level reaches the long-term average. Thereafter, the long-term average stocking level is used in the baseline stock change calculation for the entire crediting period. The project proponent shall provide a graph of the projected baseline stocking levels and the long-term average baseline stocking level for the entire crediting period (see figure 1. Sample Baseline Stocking Graph).

The following equations are used to construct the baseline stocking levels using models described in section 3.1 and wood products calculations described in section 3.2:

Annual projected baseline stocking

$$C_{BSL,PROJ} = C_{BSL,AG/BG} + C_{BSL,DW} + C_{BSL,WP} \quad (1)$$

where:

$C_{BSL,PROJ}$	Sum of all carbon stocks in the baseline scenario projection for year *t*; tons C
$C_{BSL,AG/BG}$	Carbon stock in baseline above-ground and below-ground portions of trees for all strata for year *t*; tons C
$C_{BSL,DW}$	Carbon stock in baseline dead wood pools for all strata for year *t*; tons C
$C_{BSL,WP}$	Carbon stock in baseline wood products pool for year *t*; tons C

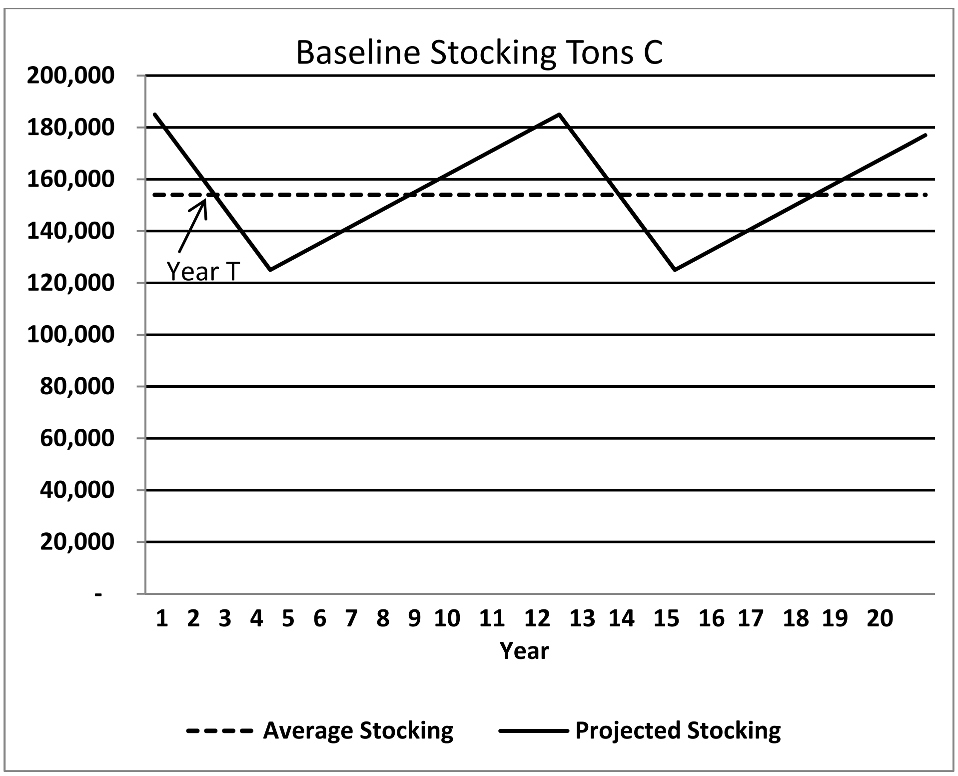
Long-term average baseline stocking

$$C_{BSL,AVE} = (\sum C_{BSL,AG/BG} + \sum C_{BSL,DW} + \sum C_{BSL,WP})/20 \quad (2)$$

where:

$C_{BSL,AVE}$	Average carbon stocks in the baseline scenario; tons C
$C_{BSL,AG/BG}$	Summed annual carbon stock in baseline above-ground and below-ground portions of trees for all strata (summed over the 20 year modeled baseline); tons C
$C_{BSL,DW}$	Summed annual carbon stock in baseline dead wood pools for all strata (summed over the 20 year modeled baseline); tons C
$C_{BSL,WP}$	Summed annual carbon stock in baseline wood products pool (summed over the 20 year modeled baseline); tons C

Figure 1. Sample Baseline Graph



If years elapsed since the start of the IFM project activity (t) is ≤ T (T=year projected stocking reaches the long-term baseline average) use projected stock change equation (4), otherwise for long-term average stock change use Δ bsl = 0 (3)

The following equations must be applied annually until year t equals T:

$$\Delta C_{BSL} = \Delta C_{BSL,P} - GHG_{BSL,E} \quad (4)$$

where:

ΔC_{BSL}	Baseline greenhouse gas removals by sinks; tons CO_2e
$\Delta C_{BSL,P}$	Stock changes in above and below -ground biomass, dead wood, and wood products in the baseline scenario; tons CO_2e
$GHG_{BSL,E}$	Change in GHG emissions as a result of the implementation of the baseline scenario within the project boundary; tons CO_2e

$$\Delta C_{BSL,P} = \Delta C_{BSL,TREE} + \Delta C_{BSL,DW} + C_{BSL,WP} \quad (5)$$

where:

$\Delta C_{BSL,P}$	Stock changes in tree biomass, dead wood, and wood products in the baseline scenario; tons CO_2e
$\Delta C_{BSL,TREE}$	Carbon stock change in biomass of trees in the baseline scenario; tons CO_2e
$\Delta C_{BSL,DW}$	Carbon stock change in dead wood pools in the baseline scenario; tons CO_2e
$C_{BSL,WP}$	Carbon stock in wood products in the baseline scenario; tons CO_2e

$$\Delta C_{BSL,TREE} = (C_{BSL,AG/BG,t} - C_{BSL,AG/BG,t-1}) * 44/12 \quad (6)$$

where:

$\Delta C_{BSL,TREE}$	Carbon stock change in biomass of trees in the baseline scenario; tons CO_2e
$C_{BSL,AG/BG}$	Sum of carbon stock in above-ground and below-ground biomass for all strata in the baseline for year t; tons C
t	Year for which carbon stock change is being calculated

$$\Delta C_{BSL,DW} = (C_{BSL,SD/LD,t} - C_{BSL,SD/LD,t-1}) * 44/12 \quad (7)$$

where:

$\Delta C_{BSL,DW}$	Carbon stock change in dead wood pools for all strata in the baseline; tons CO_2e
$C_{BSL,SD/LD}$	Sum of carbon stock in standing dead and lying dead pools for all strata in the baseline for year t; tons C
t	Year for which carbon stock change is being calculated

$$C_{BSL,WP} = (\sum C_{BSL,AWP}/20) * 44/12 \tag{8}$$

where:

$C_{BSL,WP}$ Carbon stock in wood products in the baseline for year t; tons CO_2e
$C_{BSL,AWP}$ Summed annual carbon stored in wood products during crediting period; tons C

$$GHG_{BSL,E} = BS_{BSL} * ER_{CH4} * \frac{16}{12} * GWP_{CH4} \tag{9}$$

where:

$GHG_{BSL,E}$ Change in GHG emissions as a result of the implementation of the baseline scenario within the project boundary for year t; tons CO_2e
BS_{BSL} Carbon stock in logging slash subject to burning as part of forest management for year t; tons C
ER_{CH4} Emission ratio for CH_4 (if local data on combustion efficiency is not available or if combustion efficiency cannot be estimated from fuel information, use IPCC default value, 0.01211); kg C as CH_4 (kg C burned)-1
GWP_{CH4} Global warming potential for CH_4 (IPCC default: 21 for the first commitment period of the Kyoto Protocol)

Carbon stock calculation for logging slash burned (BS_{BSL}) shall use the method described in Section 3.1.1 for bark, tops and branches, and section 3.1.2 if dead wood is selected. The reduction in carbon stocks due to slash burning in the baseline must be properly accounted in equation 6 and 7.

3.1 Stocking Level Projections in the Baseline

$C_{BSL,AG/BG}$ and $C_{BSL,DW}$ must be estimated using models of forest management across the baseline period. Modeling must be completed with a peer reviewed forestry model that has been calibrated for use in the project region. The GHG Plan must detail what model is being used and what variants have been selected. All model inputs and outputs must be available for inspection by the verifier. The baseline must be modeled over a 20-year period.

Examples of appropriate models include:

- FVS: Forest Vegetation Simulator
- SPS: Stand Projection System
- FIBER: USDA, Forest Service
- FPS: Forest Projection System by Forest Biometrics
- CRYPTOS and CACTOS: California Conifer Timber Output Simulator

Models must be:

- Peer reviewed in a process involving experts in modeling and biology/forestry/ecology
- Used only in scenarios relevant to the scope for which the model was developed and evaluated
- Parameterized for the specific conditions of the project

The output of the models must include projected volume in live aboveground tree biomass, or appropriate unit, by strata in the baseline scenario. Where model projections produce changes in volume over five year periods, the numbers shall be annualized to give a stock change number for each year.

If the output for the tree is the volume then this must be converted to biomass and carbon using equations in Section 3.1.1. If processing of alternative data on dead wood is necessary, equations in section 3.1.2 may be used. Where models do not predict dead wood dynamics, the baseline harvesting scenario may not decrease dead wood more than 50% through the crediting period.

3.1.1 Tree Carbon Stock Calculation

The mean carbon stock in aboveground biomass per unit area is estimated based on field measurements in sample plots. A sampling plan must be developed that describes the inventory process including sample size, determination of plot numbers, plot layout and locations, and data collected. Plot data used for biomass calculations may not be older than 10 years. Plots may be permanent or temporary and they may have a defined boundary or use variable radius sampling methods. Biomass for each tree is calculated from its merchantable volume using a component ratio method. The project proponent must use the same set of equations for ex-ante and ex-post baseline and project projections.

The following steps are used to calculate tree biomass:

Step 1: Determine the biomass of the merchantable component of each tree based on appropriate volume equations published by USDA Forest Service (if locally derived equations are not available use regional or national equations as appropriate) and oven-dry tree specific gravity for each species

Step 2: Determine the biomass of bark, tops and branches, and below-ground biomass as a proportion of the bole biomass based on component proportions from Jenkins and others (2003)[6]

Step 3: Using the sum of the biomass for individual trees, determine the per plot estimate of total tree biomass for each plot

Step 4: Determine the tree biomass estimate for each stratum by calculating a mean biomass per acre estimate from plot level biomass derived in step 3 multiplied times the number acres in the stratum.

Step 5: Determine total project carbon by summing the biomass of each stratum for the project area and converting biomass to dry metric tons of Carbon

[6] Jenkins, J.; Chojnacky, D.C.; Heath, L.S.; Birdsey, R.A. 2003. National Scale Biomass Estimators for United States Tree Species. Forest Science. 49(1): 12-35

$C_{AG/BG}$ = total project area biomass (kg) * .5 * .001 (10)

where:

$C_{AG/BG}$ Carbon stock in above-ground and below-ground biomass of tree; tons C for both baseline and project projection

3.1.2 Dead Wood Calculation

Dead wood included in the methodology comprises two components only – standing dead wood and lying dead wood (that is, below-ground dead wood is conservatively neglected). Considering the differences in the two components, different sampling and estimation procedures shall be used to calculate the changes in dead wood biomass of the two components.

3.1.2.1 Standing Dead Wood (if included)

Step 1: Standing dead trees shall be measured using the same criteria and monitoring frequency used for measuring live trees. The decomposed portion that corresponds to the original above-ground biomass is discounted.

Step 2: The decomposition class of the dead tree and the diameter at breast height shall be recorded and the standing dead wood is categorized under the following four decomposition classes:

1. Tree with branches and twigs that resembles a live tree (except for leaves)
2. Tree with no twigs but with persistent small and large branches
3. Tree with large branches only
4. Bole only, no branches

Step 3: Biomass must be estimated using the component ratio method used for live trees in the decomposition class. When the bole is in decomposition classes 2, 3 or 4, the biomass estimate must be limited to the main stem of the tree. If the top of the standing dead tree is missing, then top and branch biomass may be assumed to be zero. Identifiable tops on the ground meeting category 1 criteria may be directly measured. For trees broken below minimum merchantability specifications used in the tree biomass equation, existing standing dead tree height shall be used to determine tree bole biomass.

Step 4: The biomass of dead wood is determined by using the following dead wood density classes deductions: Class 1 – same as live tree biomass; Class 2 – 95% of live tree biomass; Class 3 – 90% of live tree biomass; Class 4 – 80% of live tree biomass[7].

Step 5: Determine total project standing dead carbon by summing the biomass of each stratum for the project area and converting biomass to dry metric tons of Carbon

C_{SD} = total project area biomass (kg) * .5 * .001 (11)

[7] VCS Approved Methodology VM0003, Methodology for Improved Forest Management through Extension of rotation Age.

where:

C_{SD}	Carbon stock in standing dead biomass of tree; tons C for both baseline and project projection

3.1.2.2 Lying Dead Wood (if selected)

The lying dead wood pool is highly variable, and stocks may or may not increase as the stands age depending if the forest was previously unmanaged (mature or unlogged) where it would likely increase or logged with logging slash left behind where it may decrease through time.

Step 1: Lying dead wood must be sampled using the line intersect method (Harmon and Sexton 1996)[8][9]. Two 50-meter lines (164 ft) are established bisecting each plot and the diameters of the lying dead wood (≥ 10 cm diameter [≥ 3.9 inches]) intersecting the lines are measured.

Step 2: The dead wood is assigned to one of the three density states (sound, intermediate and rotten) by species using the 'machete test', as recommended by *IPCC Good Practice Guidance for LULUCF* (2003), Section 4.3.3.5.3. The following dead wood density class deductions must be applied to the three decay classes: For Hardwoods, sound – no deduction, intermediate - .45, rotten - .42; for Softwoods, sound – no deduction, intermediate - .71, rotten - .45[10]

Step 3: The volume of lying dead wood per unit area is calculated using the equation (Warren and Olsen 1964)[11] as modified by Van Wagner (1968)[12] separately for each density class.

$$V_{LDW} = \pi^2(\sum D^2)/(8 * L) \quad (12)$$

where:

V_{ldw}	Volume of lying dead wood per unit area; m^3/ha
D	Diameter of each piece along the transect; cm
L	Length of transect; m

Step 4: Volume of lying dead wood shall be converted into biomass using the following relationship:

$$B_{LDW} = A * V_{LDW} * D_{WD} * D_{WDD} \quad (13)$$

[8] Harmon, M.E. and J. Sexton. (1996) Guidelines for measurements of wood detritus in forest ecosystems. US LTER Publication No. 20. US LTER Network Office, University of Washington, Seattle, WA, USA.

[9] A variant on the line intersect method is described by Waddell, K.L. 2002. Sampling coarse wood debris for multiple attributes in extensive resource inventories. Ecological Indicators 1: 139-153. This method may be used in place of Steps 1 to 3.

[10] USFS FIA Phase 3 proportions

[11] Warren, W.G. and Olsen, P.F. (1964) A line intersect technique for assessing logging waste. *Forest Science* 10: 267-276.

[12] Van Wagner, C.E. (1968). The line intersect method in forest fuel sampling. *Forest Science* 14: 20-26.

where:

B_{LDW}	Biomass of lying dead wood per unit area; kg/ha
A	Area; ha
D_{WD}	Basic wood density of dead wood in the density class – sound (1) , intermediate (2), and rotten (3); t d.m. m-3.
D_{WDD}	Dead wood density class deduction

Step 5: Determine total project lying dead carbon by summing the biomass of each stratum for the project area and converting biomass to dry metric tons of Carbon

C_{LD} = total project area biomass (kg) * .5 * .001 (14)

where:

C_{LD}	Carbon stock in standing dead biomass of tree; tons C for both baseline and project projection

3.2 Wood Products Calculation

Wood products shall be calculated using the US DOE 1605(b) method. The following steps must be followed to determine the amount of carbon in harvested wood:

Step 1: Calculate the annual biomass of the total volume extracted from within the project boundary with extracted timber volume differentiated into hardwood sawtimber, hardwood pulpwood, softwood sawtimber, or softwood pulpwood and converted to carbon using specific gravity for each species.

Step 2: Calculate the proportion of extracted timber that remains sequestered after 100 years. Instead of tracking annual emissions through retirement, burning and decomposition, the methodology calculates the proportion of wood products that have not been emitted to the atmosphere 100 years after harvest and assumes that this proportion is permanently sequestered. The method uses Table 1.6 from the Forestry Appendix of the Technical Guidelines of the US Department of Energy's Voluntary Reporting of Greenhouse Gases Program (known as Section 1605b)[13]. Users must determine the region the project is located in (using Figure 1.1 of the same document) and whether the timber is softwood or hardwood. The proportions defined as "In Use" and "Landfill" 100 years after production shall be used.

C4. MONITORING REQUIREMENTS FOR BASELINE RENEWAL

A project's crediting period is the finite length of time for which the baseline scenario is valid and during which a project can generate offsets against its baseline.

[13] http://www.pi.energy.gov/enhancingGHGregistry/documents/PartIForestryAppendix.pdf

A Project Proponent may apply to renew the crediting period by[14]:

- Re-submitting the GHG Project Plan in compliance with then-current GHG Program standards and criteria
- Re-evaluating of the project baseline
- Demonstrating additionality against then-current regulations, common practice and implementation barriers
- Using GHG Program-approved baseline methods, emission factors, and tools in effect at the time of crediting period renewal
- Undergoing validation and verification by an approved verifier

C5. ESTIMATION OF BASELINE UNCERTAINTY

It is assumed that the uncertainties associated with the estimates of the various input data are available, either as default values given in IPCC Guidelines (2006), IPCC GPG-LULUCF (2003), or estimates based on sound statistical sampling. Uncertainties arising from the measurement and monitoring of carbon pools and the changes in carbon pools shall always be quantified.

Indisputably conservative estimates can also be used instead of uncertainties, provided that they are based on verifiable literature sources. In this case the uncertainty is assumed to be zero. However, this module provides a procedure to combine uncertainty information and conservative estimates resulting in an overall project scenario uncertainty.

It is important that the process of project planning consider uncertainty. Procedures including stratification and the allocation of sufficient measurement plots can help ensure low uncertainty. It is good practice to consider uncertainty at an early stage to identify the data sources with the highest risk to allow the opportunity to conduct further work to diminish uncertainty. Estimation of uncertainty for pools and emissions sources for each measurement pool requires calculation of both the mean and the 90% confidence interval. In all cases uncertainty should be expressed as the 90% confidence interval as a percentage of the mean.

The uncertainty in the baseline scenario should be defined as the square root of the summed errors in each of the measurement pools. For modeled results use the confidence interval of the input inventory data. For wood products use the confidence interval of the inventory data. The errors in each pool shall be weighted by the size of the pool so that projects may reasonably target a lower precision level in pools that only form a small proportion of the total stock.

therefore, (15)

[14] American Carbon Registry (2010), *American Carbon Registry Forest Carbon Project Standard, version 2.0.* Winrock International, Little Rock, Arkansas.

$$\text{Uncertainty}_{\text{BSL,SS,i}} = \frac{\sqrt{\left(U_{BSL,SS1,i} * E_{BSL,SS1,i}\right)^2 + \left(U_{BSL,SS2,i} * E_{BSL,SS2,i}\right)^2 + \ldots + \left(U_{BSL,SSn,i} * E_{BSL,SSn,i}\right)^2}}{E_{BSL,SS1,i} + E_{BSL,SS2,i} + \ldots + E_{BSL,SSn,i}}$$

where:

$Uncertainty_{BSL,SS,i}$	Percentage uncertainty in the combined carbon stocks and greenhouse gas sources in the baseline case in stratum *i*; %
$U_{BSL,SS,i}$	Percentage uncertainty (expressed as 90% confidence interval as a percentage of the mean where appropriate) for carbon stocks and greenhouse gas sources in the baseline case in stratum *i* (1,2…n represent different carbon pools and/or GHG sources); %
$E_{BSL,SS,i}$	Carbon stock or GHG sources (e.g. trees, dead wood, emission from biomass burning) in stratum *i* (1,2…n represent different carbon pools and/or GHG sources) in the baseline case; t CO_2e
i	1, 2, 3 …*M* strata

D. WITH-PROJECT SCENARIO

D1. WITH-PROJECT STRATIFICATION

If the project activity area is not homogeneous, stratification must be carried out to improve the precision of carbon stock estimates. Different stratifications may be required for the baseline and project scenarios in order to achieve optimal accuracy and precision of the estimates of net GHG emissions reductions or GHG removal by sinks. For estimation of baseline carbon stocks strata must be defined on the basis of parameters that are key variables in any method used to estimate changes in managed forest carbon stocks, for example:

a. Management regime
b. Species or cover types
c. Size and density class
d. Site class

Project participants must present in the GHG Plan an ex-ante stratification of the project area or justify the lack of it. The number and boundaries of the strata defined *ex-ante* may change during the crediting period (*ex-post*).

The *ex-post* stratification shall be updated due to the following reasons:

- Unexpected disturbances occurring during the crediting period (e.g. due to fire, pests or disease outbreaks), affecting differently various parts of an originally homogeneous stratum
- Forest management activities (e.g. cleaning, planting, thinning, harvesting, coppicing, re-planting) may be implemented in a way that affects the existing stratification
- Established strata may be merged if reason for their establishment has disappeared

D2. MONITORING PROJECT IMPLEMENTATION

Information shall be provided, and recorded in the GHG Plan, to establish that:

- The geographic position of the project boundary is recorded for all areas of land
- The geographic coordinates of the project boundary (and any stratification inside the boundary) are established, recorded and archived. This can be achieved by field mapping (e.g. using GPS), or by using georeferenced spatial data (e.g. maps, GIS datasets, orthorectified aerial photography or georeferenced remote sensing images)
- Professionally accepted principles of forest inventory and management are implemented
- Standard operating procedures (SOPs) and quality control / quality assurance (QA/QC) procedures for forest inventory including field data collection and data management shall be applied. Use or adaptation of SOPs already applied in national forest monitoring, or available

from published handbooks, or form the *IPCC GPG LULUCF 2003*, is recommended

- The forest management plan, together with a record of the plan as actually implemented during the project shall be available for certification and verification, as appropriate

D3. MONITORING OF CARBON STOCKS IN SELECTED POOLS

Information shall be provided, and recorded in the GHG Plan, to establish that professionally accepted principles of forest inventory and management are implemented. Standard operating procedures (SOPs) and quality control / quality assurance (QA/QC) procedures for forest inventory including field data collection and data management shall be applied. Use or adaptation of SOPs already applied in national forest monitoring, or available from published handbooks, or form the *IPCC GPG LULUCF 2003*, is recommended. The forest management plan, together with a record of the plan as actually implemented during the project shall be available for verification, as appropriate.

The 90% statistical confidence interval (CI) of sampling can be no more than +/- 10% of the mean estimated amount of the combined carbon stock across all strata[15]. If the project proponent cannot meet the targeted +/- 10% of the mean at 90% confidence, then the reportable amount shall be the lower bound of the 90% confidence interval.

At a minimum the following data parameters must be monitored:

- Project area
- Sample plot area
- Tree species
- Tree Biomass
- Wood products volume
- Dead wood pool, if selected

D4. MONITORING OF EMISSION SOURCES

Emissions from biomass burning must be monitored during project activities. When applying all relevant equations provided in this methodology for the *ex-ante* calculation of net anthropogenic GHG removals by sinks, project participants shall provide transparent estimations for the parameters that are monitored during the crediting period. These estimates shall be based on measured or existing published data where possible. In addition project proponents must apply the principle of conservativeness. If different values for a parameter are equally plausible, a value that does not lead to over-estimation of net anthropogenic GHG removals by sinks must be selected.

[15] For calculating pooled CI of carbon pools across strata, see equations in Barry D. Shiver, *Sampling Techniques for Forest Resource Inventory (John Wiley & Sons, Inc, 1996)*

D5. ESTIMATION OF PROJECT EMISSION REDUCTIONS OR ENHANCED REMOVALS

This section describes the steps required to calculate ΔC_P (Net annual carbon stock change under the project scenario; tons CO_2e).

$$\Delta C_P = \Delta C_{ACT} - GHG_{P,E} \tag{16}$$

where:

ΔC_P	Project scenario net greenhouse gas removals by sinks; tons CO_2e
ΔC_{ACT}	Sum of stock change in above and below -ground biomass, dead wood pools, and wood products in the project scenario; tons CO_2e
$GHG_{P,E}$	Change in GHG emissions as a result of the implementation of the project scenario within the project boundary for year t; tons CO_2e

$$\Delta C_{ACT} = (C_{PP,t} - C_{PP,t-1}) * 44/12 \tag{17}$$

where:

C_{PP}	Carbon stock in all selected pools in the project scenario for year t; tons C
t	Year for which carbon stock change is being calculated

$$C_{PP} = C_{AG/BG} + C_{DW} + C_{WP} \tag{18}$$

where:

$C_{AG/BG}$	Sum of carbon stock in above-ground and below-ground portions of trees for all strata for year t
C_{DW}	Sum of carbon stock in dead wood pools for all strata for year t; tons C
C_{WP}	Sum of carbon stock in wood products for all strata for year t; tons C

$$GHG_{P,E} = BS_P * ER_{CH4} * \frac{16}{12} * GWP_{CH4} \tag{19}$$

where:

$GHG_{P,E}$	Change in GHG emissions as a result of the implementation of the project scenario within the project boundary for year t; tons CO_2e

BS_P	Carbon stock in logging slash subject to burning as part of forest management for year t; tons C
ER_{CH4}	Emission ratio for CH_4 (if local data on combustion efficiency is not available or if combustion efficiency cannot be estimated from fuel information, use IPCC default value, 0.01211); kg C as CH_4 (kg C burned)-1
GWP_{CH4}	Global warming potential for CH_4 (IPCC default: 21 for the first commitment period of the Kyoto Protocol)

Carbon stock calculation for logging slash burned (BS_P) shall use the method described in Section 3.1.1 for bark, tops and branches, and Section 3.1.2 if dead wood is selected. The reduction in carbon stocks due to slash burning due to project activities must be properly accounted in equation 18.

5.1 Tree Biomass, Dead Wood Carbon Calculation, Wood Products

The project proponent must use the same set of equations used in Section C3.1.1, C3.1.2, and C3.2 to calculate carbon stocks in the project scenario.

D6. MONITORING OF ACTIVITY SHIFTING LEAKAGE

As per the applicability conditions, there may be no leakage beyond *de minimis* levels through activity shifting to other lands owned, or under management control, by the timber rights owner. If leakage from activity shifting is discovered, project proponents must estimate the associated leakage amount and deduct ERTs to fully compensate for emissions resulting from activity shifting leakage.

If the project decreases wood product production by >5% relative to the baseline then the project developer and all associated land owners must demonstrate that there is no leakage within their operations – i.e., on other lands they manage/operate outside the bounds of the ACR carbon project. Such a demonstration may include:

- Historical records covering project proponent ownership showing trends in harvest volumes paired with records from the with-project time period showing no deviation from historical trends over most recent 10-year average
- Forest management plans prepared ≥24 months prior to the start of the project showing harvest plans on all owned/managed lands paired with records from the with-project time period showing and no deviation from management plans
- Entity-wide management certification that requires sustainable practices (programs can include FSC, SFI, or ATF). Management certification must cover all entity owned lands with active timber management programs.

D7. ESTIMATION OF EMISSIONS DUE TO MARKET LEAKAGE

Reductions in product outputs due to project activity may be compensated by other entities in the marketplace. Those emissions must be included in the quantification of project benefits.

If the project is able to demonstrate that any decrease in total wood products produced by the project relative to the baseline is less than 5% over the crediting period then:

$$LK = 0 \tag{20}$$

Where project activities decrease total wood products produced by the project relative to the baseline by more than 5% but less than 25% over the crediting period, market leakage deduction is 10%. (according to VCS AFOLU Guidance Document[16])

$$LK = 0.1 \tag{21}$$

Where project activities decrease total wood products produced by the project relative to the baseline by 25% or more over the crediting period, the amount of leakage is determined by where harvesting would likely be displaced to. If in the forests to which displacement would occur a lower proportion of forest biomass in commercial species is in merchantable material than in project area, then in order to extract a given volume higher emissions should be expected as more trees will need to be cut to supply the same volume. In contrast if a higher proportion of the total biomass of commercial species is merchantable in the displacement forest than in the project forests then a smaller area would have to be harvested and lower emissions would result.

Each project thus shall calculate within each stratum the proportion of total biomass in commercial species that is merchantable (*PMP*). This shall then be compared to mean proportion of total biomass that is merchantable for each forest type (*PML*)[17].

Merchantable biomass is defined as: "Total gross biomass (including bark) of a tree 5 inches (12.7 cm) DBH or larger from a 1 foot (30.48 cm) stump to a minimum 4 inches top DOB of the central stem" *Definition from US Forest Service FIA Program*

The following deduction factors (*LK*) shall be used:

Where:

PML is equal (± 15%) to PMP: *LK=* 0.4 (22)

PML is > 15% less than PMP: *LK=* 0.7 (23)

[16] http://www.v-c-s.org/docs/AFOLU%20Guidance%20Document.pdf
[17] It is assumed harvesting will be displaced to similar forest types.

PML is > 15% greater than PMP: $LK = 0.2$ (24)

where:

PML_{FT}	Mean merchantable biomass as a proportion of total aboveground tree biomass for each forest type; % (see default values below)
PMP	Merchantable biomass as a proportion of total aboveground tree biomass for each stratum within the project boundaries; %
LK	Leakage factor for market-effects calculation

For projects with more than one forest type, a weighted area LK must be calculated using the following equation:

$$LK = \left(\frac{A_{FT1}}{A_{TOT}} * LK_{FT1}\right) + \left(\frac{A_{FT2}}{A_{TOT}} * LK_{FT2}\right) + \left(\frac{A_{FT3}}{A_{TOT}} * LK_{FT3}\right) + \ \ldots \quad (25)$$

where:

A_{FT}	Area in Forest Type (1,2,3…)
A_{TOT}	Total project area
LK_{FT}	Deduction factor for forest type from equation 22-24

Default values for PML[18]:

Forest Type Group	Merchantable Biomass as Proportion of Total Biomass
White Red Jack Pine	77%
Spruce Fir	58%
Longleaf Slash Pine	73%
Loblolly Shortleaf Pine	73%
Ponderosa Pine	64%

[18] The FIA mapmaker program (http://www.ncrs2.fs.fed.us/4801/fiadb/fim30/wcfim30.asp) was used to calculate PML. For the lower 48 states the total biomass and merchantable biomass by forest type were downloaded in order to calculate the proportions given here

Oak Pine	**71%**
Oak Hickory	**73%**
Oak Gum Cypress	**72%**
Elm Ash Cottonwood	**73%**
Maple Beech Birch	**76%**
Aspen Birch	**61%**
Douglas Fir	**70%**
Western White Pine	**62%**
Fir-Spruce/Mountain Hemlock	**62%**
Lodgepole Pine	**64%**
Hemlock/Sitka Spruce	**67%**
Western Larch	**66%**
Redwood	**43%**
Western Oak	**69%**

D8. ESTIMATION OF WITH-PROJECT UNCERTAINTY

It is assumed that the uncertainties associated with the estimates of the various input data are available, either as default values given in IPCC Guidelines (2006), IPCC GPG-LULUCF (2003), or estimates based on sound statistical sampling. Uncertainties arising from the measurement and monitoring of carbon pools and the changes in carbon pools shall always be quantified.

Indisputably conservative estimates can also be used instead of uncertainties, provided that they are based on verifiable literature sources. In this case the uncertainty is assumed to be zero. However, this module provides a procedure to combine uncertainty information and conservative estimates resulting in an overall project scenario uncertainty.

As with baseline uncertainty, it is important that the process of project planning consider uncertainty. Procedures including stratification and the allocation of sufficient measurement plots can help ensure low uncertainty. It is good practice to consider uncertainty at an early stage to identify the data sources with the highest risk to allow the opportunity to conduct further work to diminish uncertainty. Estimation of uncertainty for pools and emissions sources for each measurement pool requires calculation of both the mean and the 90% confidence interval. In all cases uncertainty should be expressed as the 90% confidence interval as a percentage of the mean.

The uncertainty in the project scenario should be defined as the square root of the summed errors in each of the measurement pools. For modeled results use the confidence interval of the input inventory data. For wood products with measured and documented harvest volume removals use zero as the confidence interval. For estimated wood product removal use the confidence interval of the inventory data. The errors in each pool can be weighted by the size of the pool so that projects may reasonably target a lower precision level in pools that only form a small proportion of the total stock.

Therefore,

$$\text{Uncertainty}_{\text{P,SS,i}} = \frac{\sqrt{\left(U_{P,SS1,i} * E_{P,SS1,i}\right)^2 + \left(U_{P,SS2,i} * E_{P,SS2,i}\right)^2 + \ldots + \left(U_{P,SSn,i} * E_{P,SSn,i}\right)^2}}{E_{P,SS1,i} + E_{P,SS2,i} + \ldots + E_{P,SSn,i}} \tag{26}$$

where:

$Uncertainty_{P,SS,i}$	Percentage uncertainty in the combined carbon stocks and greenhouse gas sources in the project scenario case in stratum *i*; %
$U_{P,SS,i}$	Percentage uncertainty (expressed as 90% confidence interval as a percentage of the mean where appropriate) for carbon stocks and greenhouse gas sources in the project scenario case in stratum *i* (1,2…n represent different carbon pools and/or GHG sources); %
$E_{BSL,SS,i}$	Carbon stock or GHG sources (e.g. trees, dead wood, emission from biomass burning) in stratum *i* (1,2…n represent different carbon pools and/or GHG sources) in the project scenario case; t CO_2e
i	1, 2, 3 …*M* strata

E. EX-ANTE ESTIMATION

E1. EX-ANTE ESTIMATION METHODS

The project proponent must make an *ex ante* calculation of all net anthropogenic GHG removals and emissions for all included sinks and sources for the entire crediting period. Project participants shall provide estimates of the values of those parameters that are not available before the start of monitoring activities. Project participants must retain a conservative approach in making these estimates.

Uncertainties arising from, for example, biomass expansion factors or wood density, could result in unreliable estimates of both baseline net GHG removals by sinks and the actual net GHG removals by sinks especially when global default values are used. Project proponents shall identify key parameters that would significantly influence the accuracy of estimates. Local values that are specific to the project circumstances must then be obtained for these key parameters, whenever possible. These values must be based on:

- Data from well-referenced peer-reviewed literature or other well-established published sources; or
- National inventory data or default data from IPCC literature that has, whenever possible and necessary, been checked for consistency against available local data specific to the project circumstances; or
- In the absence of the above sources of information, expert opinion may be used to assist with data selection. Experts will often provide a range of data, as well as a most probable value for the data. The rationale for selecting a particular data value must be briefly noted in the GHG plan. For any data provided by experts, the GHG Plan shall also record the expert's name, affiliation, and principal qualification as an expert– plus inclusion of a 1-page summary CV for each expert consulted, included in an annex

When choosing key parameters based on information that is not specific to the project circumstances, such as in use of default data, project proponents must select values that will lead to an accurate estimation of net GHG removals by sinks, taking into account uncertainties. If uncertainty is significant, project participants must choose data such that it tends to underestimate, rather than overestimate, net GHG removals by sinks[19].

[19] CDM Approved Consolidated Methodology AR-ACM0001, "Afforestation and Reforestation of Degraded Land"

F. QA/QC AND UNCERTAINTY

F1. METHODS FOR QUALITY ASSURANCE

Standard operating procedures (SOPs) and quality control / quality assurance (QA/QC) procedures for forest inventory including field data collection and data management shall be documented. Use or adaptation of SOPs already applied in national forest monitoring, or available from published handbooks, or from the *IPCC GPG LULUCF 2003*, is recommended.

F2. METHODS FOR QUALITY CONTROL

Project Proponents shall consider all relevant information that may affect the accounting and quantification of GHG reductions/removals, including estimating and accounting for any decreases in carbon pools and/or increases in GHG emission sources. This methodology sets a *de minimis* threshold of 3% of the final calculation of emission reductions. For the purpose of completeness any decreases in carbon pools and/or increases in GHG emission sources must be included if they exceed the *de minimis* threshold. Any exclusion using the *de minimis* principle shall be justified using fully documented *ex ante* calculations.

F3. CALCULATION OF TOTAL PROJECT UNCERTAINTY

The following equation must be applied:

$$UNC = \sqrt{UNC_{BSL}^{\ 2} + UNC_{P}^{\ 2}} \qquad (27)$$

where:

UNC	Total project Uncertainty, in %
UNC_{BSL}	Baseline uncertainty, in % (Section C5)
UNC_{P}	With-project uncertainty, in % (Section D8)

If calculated UNC in equation (27) is <10%, then UNC shall be considered 0% in equation (28).

G. CALCULATION OF ERTs

G1. CALCULATION OF ERTs

$$C_{ACR,t} = (\Delta C_P - \Delta C_{BSL}) * (1 - LK) * (1 - UNC) \quad (28)$$

Where:

$C_{ACR,t}$	Annual net greenhouse gas emission reductions at time *t;* tons CO_2e
ΔC_P	Carbon stock changes and greenhouse gas emissions under the project scenario at time *t,* tons CO_2e (Section D5)
ΔC_{BSL}	Carbon stock changes and greenhouse gas emissions under the baseline scenario at time *t,* tons CO_2e (Section C3)
LK	Leakage discount (Section D7)
UNC	Total project uncertainty, in % (Section F3)

$$ERT_t = (C_{ACR,t}) * (1 - BUF) \quad (29)$$

Where:

$ERT_{,t}$	Number of Emission Reduction Tons of vintage year t that are issued with valid verification report
BUF	The non-permanence buffer deduction as calculated by the *ACR Tool for Risk Analysis and Buffer Determination or* the *VCS Tool for AFOLU Non-Permanence Risk Analysis and Buffer Determination* (no deduction if an ACR approved insurance product is used); fraction (Section B5)