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Application of the Oeko-Institut/WWF-US/ EDF methodology for assessing the quality of carbon credits

This document presents results from the application of version 3.0 of a methodology, developed by Oeko-Institut, World Wildlife Fund (WWF-US) and Environmental Defense Fund (EDF), for assessing the quality of carbon credits. The methodology is applied by Oeko-Institut with support by Carbon Limits, Greenhouse Gas Management Institute (GHGMI), INFRAS, Stockholm Environment Institute, and individual carbon market experts. This document evaluates one specific criterion or sub-criterion with respect to a specific carbon crediting program, project type, quantification methodology and/or host country, as specified in the below table. Please note that the CCQI website Site terms and Privacy Policy apply with respect to any use of the information provided in this document. Further information on the project and the methodology can be found here: www.carboncreditquality.org

Sub-criterion:	1.3.2 Robustness of the quantification methodologies applied to determine emission reductions or removals
Project type:	Establishment of natural forest
Quantification methodology:	Climate Action Reserve U.S. Forest Project Protocol Version 4.0 – Reforestation Project Type
Assessment based on carbon crediting program documents valid as of:	15 May 2022
Date of final assessment:	31 January 2023
Score:	3

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Assessment

Relevant scoring methodology provisions

The methodology assesses the robustness of the quantification methodologies applied by the carbon crediting program to determine emission reductions or removals. The assessment of the quantification methodologies considers the degree of conservativeness in the light of the uncertainty of the emission reductions or removals. The assessment is based on the likelihood that the emission reductions or removals are under-estimated, estimated accurately, or over-estimated, as follows (see further details in the methodology):

Assessment outcome	Score
It is very likely (i.e., a probability of more than 90%) that the emission reductions or removals are underestimated, taking into account the uncertainty in quantifying the emission reductions or removals	5
It is likely (i.e., a probability of more than 66%) that the emission reductions or removals are underestimated, taking into account the uncertainty in quantifying the emission reductions or removals OR The emission reductions or removals are likely to be estimated accurately (i.e., there is about the same probability that they are underestimated or overestimated) and uncertainty in the estimates of the emission reductions or removals is low (i.e., up to ±10%)	4
The emission reductions or removals are likely to be estimated accurately (i.e., there is about the same probability that they are underestimated or overestimated) but there is medium to high uncertainty (i.e., ±10-50%) in the estimates of the emission reductions or removals OR It is likely (i.e., a probability of more than 66%) or very likely (i.e., a probability of more than 90%) that the emission reductions or removals are overestimated, taking into account the uncertainty in quantifying the emission reductions or removals, but the degree of overestimation is likely to be low (i.e., up to ±10%)	3
The emission reductions or removals are likely to be estimated accurately (i.e., there is about the same probability that they are underestimated or overestimated) but there is very high uncertainty (i.e., larger than ±50%) in the estimates of the emission reductions or removals OR It is likely (i.e., a probability of more than 66%) or very likely (i.e., a probability of more than 90%) that the emission reductions or removals are overestimated, taking into account the uncertainty in quantifying the emission reductions or removals, and the degree of overestimation is likely to be medium (±10-30%)	2
It is likely (i.e., a probability of more than 66%) or very likely (i.e., a probability of more than 90%) that the emission reductions or removals are overestimated, taking into account the uncertainty in quantifying the emission reductions or removals, and the degree of overestimation is likely to be large (i.e., larger than ±30%)	1

Information sources considered

1 Climate Action Reserve Forest Project Protocol, Version 4.0

2 Quantification Guidance for Use with Forest Carbon Projects (June 28, 2017)

3 Standardized Inventory Methodology (Version 1.0)

4 Martin, A. R., Doraisami, M. and Thomas, S. C. (2018). Global patterns in wood carbon concentration across the world's trees and forests. *Nature Geoscience*, 11(12). 915–20. DOI:10.1038/s41561-018-0246-x.

5 Barbara Bomfim, et al. (in preparation). Is flexibility in REDD+ carbon accounting methods leading to overcrediting?

Assessment outcome

The quantification methodology is assigned a score of 3.

Justification of assessment

Project type

This assessment refers to the following project type:

"Establishment of a forest on non-forest land areas that are ecologically appropriate for forests, excluding naturally non-forested biomes and semi-natural grasslands as well as the boreal region due to albedo-effects. The forest will not be used for any commercial purposes, such as harvesting, but may be used for sustainable subsistence. The tree species composition is based on the natural forest type of the area. This project type does not include the restoration of marine coastal ecosystems, such as mangroves."

This is within the scope of the quantification methodology, as the methodology covers any establishment of trees on previously unforested land, including mixed native species, with or without harvesting (Source 1).

Selection of emission sources for calculating emission reductions or removals

The CAR methodology explicitly identifies the following “sources, sinks, and reservoirs” relevant for quantifying net removals associated with reforestation projects:

Table 1 Assessment of sources, sinks and reservoirs covered

Source, sink, or reservoir	Included in quantification methodology?	Relevant for this assessment?
Standing live carbon (carbon in all portions of living trees)	Yes	Yes. Primary reservoir for removals. Also a potential source of emissions at project initiation.
Shrubs and herbaceous understory carbon	Yes	Yes. Potential source of emissions at project initiation.
Standing dead carbon (carbon in all portions of dead, standing trees)	Yes	Yes. May be a reservoir of additional stored carbon. Also a potential source of emissions at project initiation.
Lying dead wood carbon	No. The methodology requires retention of lying deadwood as part of overall requirements for “natural forest management,” but does not require accounting for changes in carbon in this reservoir. This is because it is assumed that pre-existing lying dead wood on the project site would have emitted all carbon in the baseline.	Yes. Could be a source of emissions at site preparation.

Litter and duff carbon (carbon in dead plant material)	No. Could be source of emissions during site preparation, but this is considered de *minimis*.	Yes. Could be source of emissions during site preparation
Soil carbon	Yes. All projects must use standardized guidance to account for potential soil carbon emissions associated with management activities	Yes. Could be source of emissions from site preparation activities. Since no harvesting is assumed for the assessed project type, however, significant effects on soil carbon are unlikely.
Carbon in in-use forest products	Yes. Some projects could significantly increase carbon in harvested wood products.	No. No harvesting assumed.[1]
Forest product carbon in landfills	Yes. Some projects could significantly increase carbon landfilled wood products.	No. No harvesting assumed.
Mobile combustion emissions from site preparation activities	Yes. Could be significant source of emissions.	Yes.
Burning of woody biomass as part of site preparation	No	Yes. May result in significant emissions of CH_4 and N_2O. CO_2 emissions are accounted for as carbon stock losses, so not separately included in this source.
Mobile combustion emissions from ongoing project operation and maintenance	No. Assumes emissions will not differ from baselines levels, and that such emissions will be covered by a regulatory cap.	No. Likely insignificant since the assessed project activity involves no harvesting. (Note: the methodology's assumptions for this source could be scrutinized for projects that do involve harvesting, since in that case it seems unlikely that emissions would not differ from baseline levels.)
Stationary combustion emissions from ongoing project operation and maintenance	No. Assumed to be largely irrelevant and/or equivalent to baseline levels (e.g., project owner office building emissions).	Yes, in principle, but ignored for reasons stated in the methodology
Emissions from clearing of forest land **outside** the project area	Yes. Afforestation 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).	Yes. Significant potential source of leakage.

Emissions/removals from changes in harvesting on forest land outside the project area	No. In principle, reforestation with harvesting could lead to reduced harvesting on other lands, but this is conservatively not accounted for.	No. No harvesting is assumed.
Combustion emissions from production, transportation, and disposal of forest products	No. Excluded because "assumes that combustion emissions will be controlled under a regulatory cap-and-trade program in the near future."	No. Not relevant because no harvesting is involved. (Note: the methodology's assumptions for this source could be scrutinized for projects that do involve harvesting, since in that case it seems unlikely that emissions would not differ from baseline levels.)
Combustion emissions from production, transportation, and disposal of alternative materials to forest products	No. Increased wood product production could displace higher carbon-intensity alternative building materials, like cement or steel. This displacement is conservatively not accounted for.	No. No harvesting is assumed.
Emissions from decomposition of forest products	Yes. "CO2 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."	No. No harvesting is assumed.

Overall, the methodology defines a comprehensive GHG assessment boundary for this project type. There are no apparent "missing" reservoirs or sources of emissions in terms of what is explicitly considered. However, in the case of "lying dead wood" and "litter and duff" carbon pools, no quantification is required. Excluding these reservoirs could in principle result in overestimation of emission reductions/removals – this is assessed further below.

Determination of baseline emissions and removals

The methodology requires project owners to present a "qualitative characterization" of a business-as-usual baseline scenario that takes into account "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 baseline therefore must take into account both possible growth of existing trees and vegetation over the crediting period in the absence legal requirements, as well as active planting of trees that may be legally required. Initial carbon stocks for shrubs and soils in the project area must be inventoried

[1] Because this project activity involves no harvesting, methodology requirements related to accounting for carbon stored in harvested wood products are not relevant. Quantifying carbon stored in harvested wood products could be a significant source of uncertainty and potential overestimation for reforestation/afforestation projects that do involve harvesting; crediting carbon stored in products would also introduce non-permanence concerns.

prior to any site preparation. Pre-existing live trees must also be identified. The qualitative baseline characterization must then be modelled, using the initial inventory of trees as a starting point, to calculate the expected change in carbon stocks without the project over a 100-year crediting period.

Possible concerns here include:

OE1 **Modelling of baseline carbon stocks (e.g., in pre-existing trees)**. There is clearly some leeway in how project proponents define and develop a qualitative characterization of the baseline, particularly in terms of the characterization of what may happen with existing live trees in the absence of the project (shrub and soil baseline carbon stocks are assumed to be static). No specific guidance is provided on how this should be done to ensure conservativeness, for example. Nor is there guidance with respect to possible changes in common practice in an area. The risk here is difficult to assess generically. However, given a crediting period of up to 100 years, assuming continuation of pre-existing land cover and land use practices may not be conservative for many geographic areas.

OE2 **Lack of required baseline adjustment to reflect changes in legal requirements, incentives, or common practice**. Similarly, while legal requirements must be reflected at the time the project is initiated, there appear to be no provisions for updating the baseline if new legal requirements (or incentives) are imposed in the future that would induce tree planting on the project area. Since the baseline period (and crediting period) extend for 100 years, this could present a distinct – if difficult to quantify – risk of overestimation of removals.

Finally, related to this, there are no provisions for anticipating in the baseline the possible effects of meeting NDC or LEDS targets. This could be a significant concern over the long term (up to 100 years).

Determination of project emissions and removals

The methodology requires quantification of both project emissions and projects removals.

Project emissions are quantified in different ways, depending on the sources involved. Emissions from major carbon reservoirs within the project area (live trees and standing dead trees) are quantified by measuring changes in the carbon stocks within those reservoirs over time, as part of regular updating of the project area's inventory. If a disturbance event were to affect planted trees, for example, emissions would be determined through an updated inventory after the disturbance. (These emissions would essentially be quantified as negative net removals.)

U1 **Quantification of biogenic site preparation emissions (shrubs & soils)**. Site preparation is assumed to release carbon in shrubs and soils. Carbon stocks in shrubs and soils must be measured prior to site preparation, and release of carbon due to site preparation must be estimated. The methodology and quantification guidance are, however, not clear on how emissions should be estimated for shrubs, e.g., whether all or only part of the carbon measured prior to preparation is assumed to be emitted.

Release of carbon stocks in soils is determined using standardized lookup tables in the Forest Protocol Quantification Guidance. Standard percentages of soil carbon released due to site preparation are provided based on soil type and a qualitative characterization of site preparation (e.g., "very light" to "heavy"). Percentages range from 0% to 80%. Because of these qualitative characterizations, there may be some discretion for project proponents to

choose a “lighter” characterization, which in some cases could result in significantly lower emission estimates (e.g., reducing from 10% to 5% assumed emissions).

Carbon stocks in both shrubs and soils are assumed to be static after site preparation (they are not further measured or quantified and projects cannot receive credit for later enhancing these carbon reservoirs).

OE3 **Exclusion of non-CO_2 emissions from burning biomass at site preparation.** The protocol effectively assumes that all site preparation will consist of mechanical removal of existing vegetation. It does not account for situations where project proponents might burn pre-existing biomass as a site preparation method, which could result in significant CH_4 and N_2O emissions in addition to release of CO_2. Where this occurs, this may result in significant underestimation of project emissions, and therefore overestimation of net removals. However, it is not known how common this method of site preparation is in the United States.

OE4 **Exclusion of lying dead wood, litter, and duff emissions due to site preparation**. Version 4 of the CAR Forest Project Protocol assumes no *net* site preparation emissions from lying dead wood. The stated assumption is that any carbon in lying dead wood present prior to preparation would have been emitted over 100 years in the baseline, so net emissions over 100 years are assumed to be equivalent. This may be a reasonable rough assumption (although some lying dead wood carbon could also be incorporate in soils, if left undisturbed). However, it is not conservative with respect to the timing of emissions. This could therefore be a (minor) source of overestimation. Site preparation emissions associated with litter and duff disturbance are not quantified, because they are considered *de minimis*. This could also be a minor source of overestimation for some projects.

U2 **Inclusion of mobile combustion emissions due to site preparation**. Emissions from mobile combustion (vehicles & equipment emissions) at site preparation are estimated using standard emission factors per acre of project area. The required emission factor varies by the intensity of site preparation (“light” to “heavy’). Because of these qualitative characterizations, there may be some discretion for project proponents to choose a “lighter” characterization, which in some cases could result in significantly lower emission estimates (e.g., 0.2 vs. 0.43 t CO_2 per acre).

Project removals are quantified by periodically measuring carbon in live trees and standing dead trees associated with new tree planting (these are actively distinguished from pre-existing trees). The CAR Standardized Inventory Methodology is used to quantify onsite carbon stocks in these reservoirs, using prescribed sampling methodologies. Not all sampling plots are measured at every verification. For plots that have not been newly measured, growth in trees is assumed based on CAR-approved growth models (which are applied commonly in forest inventory analysis).

OE5 **Use of 0.5 carbon fraction ratio for all tree species.** The methodology uses a 0.5 ratio for the fraction of carbon in tree biomass (Source 1). At least one study suggests that using a ratio of 0.5 could significantly overestimate carbon stocks in a variety of tree species (especially angiosperms) in different climate zones (Sources 4 and 5). The prescribed use of 0.5 could result in overestimation of removals by 5% or more for projects involving primarily angiosperms in the United States.

UE1 **Application of uncertainty discounts when measuring carbon stocks (live & dead trees).** Sampling results in statistical uncertainty. The Quantification Guidance indicates the sampling error (defined at a 90% confidence interval) cannot exceed 20% of the total carbon

inventory estimate (if it does, the inventory is rejected). A “confidence deduction” is applied if the sampling error is between 5% and 20% of the total inventory estimate, equal to the sampling error minus 5%. For example, if the sampling error is 15%, then the inventory estimate used to quantify removals must be reduced by 10%. If the sampling error is 5% or less, no deduction is applied.

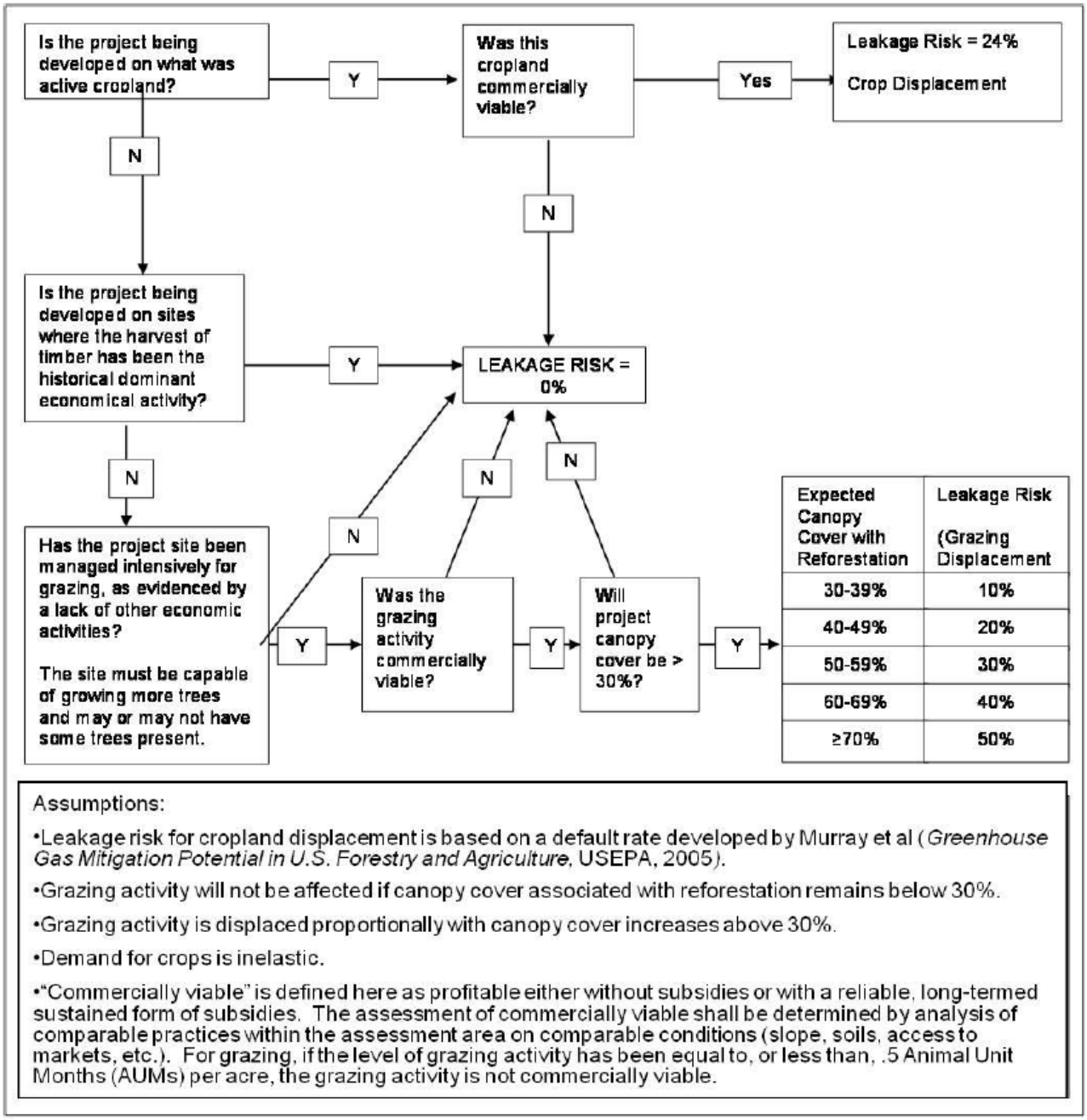
The methods prescribed should produce a conservative estimate of carbon stocks in trees. Note, however, that this assessment has not attempted to evaluate the rigor or conservativeness of prescribed sampling methods, plot selection, growth models, and statistical methods used to determine onsite carbon stocks.

Determination of leakage emissions

Estimation of “leakage” emissions due to site preparation are discussed above (these are characterized as “secondary effects” in the methodology).

Leakage associated with reforestation projects can also occur, however, if reforestation displaces other land uses, e.g., by converting agricultural land to forest land, leading to a displacement of agricultural production. Potential leakage from taking cropland or grazing land out of production is estimated using a standardized approach, using a “decision tree” and leakage deduction defaults (see below). For project areas on cropland or grazing land sites, total quantified removals must be adjusted downward based on the appropriate leakage deduction percentage.

Figure 1 CAR reforestation project leakage deduction "decision tree"



U3 Methods to determine leakage emissions. The approach to potential leakage deductions may involve significant uncertainty, because it is uncertain how well the percentage deductions would be reasonable estimates for individual project circumstances. In addition, the assessment of some of the decision tree questions could involve considerable uncertainty. For example, the "commercial viability" of continuing an activity may depend on assumptions of future commodity prices. There may also be information asymmetries between project proponents and auditors in verifying the information.

Summary and conclusion

The following Table 2 summarizes the assessment. For each of the previously discussed elements it derives the potential impact on emission reduction quantification.

Table 2 Relevant elements of assessment and qualitative ratings

Element	Fraction of projects affected by this element[2]	Average degree of under- or overestimation where element materializes[3]	Variability among projects where element materializes[4]
Elements potentially overestimating emission reductions/removals			
OE1 Modelling of baseline carbon stocks (e.g., in pre-existing trees)	High (modelling may be accurate for shorter periods, but over 100 years significant uncertainty may exist for many projects)	Low (carbon in pre-existing trees & vegetation is small compared to carbon in new forest cover, so the typical degree of overestimation may be low)	Medium
OE2 Lack of required baseline adjustment to reflect changes in legal requirements, incentives, or common practice	High (this assessment is subjective, but over 100 years the likelihood of changes in policy context and common practice seems reasonably high; could depend on project context)	Unknown (depends on the nature of requirements, incentives, common practice)	High (could be up to 100%, for example, if afforestation occurs in the baseline but simply at a later date)

[2] This parameter refers to the likely fraction of individual projects (applying the same methodology) that are affected by this element, considering the potential portfolio of projects. “Low” indicates that the element is estimated to be relevant for less than one third of the projects, “Medium” for one to two thirds of the projects, “High” for more than two third of the projects, and “All” for all of the projects. “Unknown” indicates that no information on the likely fraction of projects affected is available.

[3] This parameter refers to the likely average degree / magnitude to which the element contributes to an over- or underestimation of the total emission reductions or removals for those projects for which this element materializes (i.e., the assessment shall not refer to average over- or underestimation resulting from all projects). “Low” indicates an estimated deviation of the calculated emission reductions or removals by less than 10% from the actual (unknown) emission reductions or removals, “Medium” refers to an estimated deviation of 10 to 30%, and high refers to an estimated deviation larger than 30%. “Unknown” indicates that it is likely that the element contributes to an over- or underestimation (e. g. overestimation of emission reductions in case of an omitted project emission source) but that no information is available on the degree / magnitude of over- or underestimation. Where relevant information is available, the degree of over- or underestimation resulting from the element may be expressed through a percentage range.

[4] This refers to the variability with respect to the element among those projects for which the element materializes. “Low” means that the variability of the relevant element among the projects is at most ±10% based on a 95% confidence interval. For example, an emission factor may be estimated to vary between values from 18 and 22 among projects, with 20 being the mean value. “Medium” refers to a variability of at most ±30%, and “High” of more than ±30%.

OE3 Exclusion of non-CO_2 emissions from burning biomass at site preparation	Unknown	Low	Low
OE4 Exclusion of lying dead wood, litter, and duff emissions due to site preparation	High	Low	Medium
OE5 Use of 0.5 carbon fraction ratio for all tree species	Unknown (specific to projects involving primarily angiosperms)	Low	Low-Medium (depends on species mix)
Elements potentially underestimating emission reductions/removals			
UE1 Application of uncertainty discounts when measuring carbon stocks (live & dead trees)	Medium (depends on how many projects have 5% or greater sampling error)	Low	Medium
Elements with unknown impact			
U1 Quantification of biogenic site preparation emissions (shrubs & soils)	Unknown (generally, inclusion of these emissions is conservative, but subjectivity/discretion allowed in determining emission factors could result in overestimation in some cases)	Low	Medium
U2 Inclusion of mobile combustion emissions due to site preparation	Unknown	Low	Medium (generally, inclusion of these emissions is conservative, but methods could in fact result in overestimation of net removals if the wrong default factor is used)
U3 Methods to determine leakage emissions	Unknown (depends on circumstances)	Unknown	High (depends on project)

Based on this summary, the quantification methodology is assigned a score of 3 overall. This is primarily due to potential – but difficult to quantify or assess – risks associated with baseline legal requirements, incentives, and practices over the 100-year crediting period that is assumed; and leakage deduction estimates, which can be either very large or non-existent depending on how crucial questions related to prior cropland and grazing land practices are answered. For individual reforestation projects, leakage risks may not be relevant, in which case a score of 4 could be warranted, but only if baseline changes in practice and legal context are not considered likely.

Annex: Summary of changes from previous assessment sheet versions

The following table describes the main substantive changes implemented in comparison to the assessment from 31 May 2022.

Topic	Rationale
Non-CO_2 emissions from burning of biomass	Not discussed in the previous version of this assessment sheet. Burning biomass for site preparation may not be as common in the United States as in other parts of the world, but this is an important source of potential emissions addressed in other methodologies (including other methodologies applicable to the United States).
Clarification of elements	Elements identified in Table 2 were explicitly identified in the discussion, and clarifications added in the discussion text where appropriate. Elements U2 and U3 were transposed in order, to reflect their discussion in the text.
Carbon fraction	One element related to use of a default value of 0.5 for the carbon fraction ratio was added (OE5)