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RESERVE

U.S. and Canada Biochar Protocol

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Acknowledgements

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Abbreviations and Acronyms

CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CH_4	Methane
CRT	Climate Reserve Tonne
EBC	European Biochar Certificate
GHG	Greenhouse gas
IBI	International Biochar Initiative
N_2O	Nitrous oxide
Reserve	Climate Action Reserve
SSR	Source, sink, and/or reservoir
t	Metric ton (or tonne)

1 Introduction

The Climate Action Reserve (Reserve) Biochar Protocol provides guidance to account for, report, and verify greenhouse gas (GHG) emission reductions and carbon removals associated with the production and application of biochar.

The **Climate Action Reserve** is the most trusted, efficient, and experienced offset registry for global carbon markets. A pioneer in carbon accounting, the Reserve promotes and fosters the reduction of greenhouse gas (GHG) emissions through credible market-based policies and solutions. As a high-quality offset registry for voluntary carbon markets, it establishes rigorous standards involving multi-sector stakeholder workgroup development and local engagement and issues carbon credits in a transparent and publicly available system. The organization also supports compliance carbon markets in California, Washington and internationally. The Reserve is an environmental nonprofit organization headquartered in Los Angeles, California with staff members located around the world. For more information, please visit www.climateactionreserve.org.

Project developers that initiate biochar projects use this document to quantify and register GHG reductions and carbon removals with the Reserve. The protocol provides eligibility rules, methods to calculate reductions and removals, performance-monitoring instructions, and procedures for reporting project information to the Reserve. Additionally, all project reports receive independent verification by ISO-accredited and Reserve-approved verification bodies. Guidance for verification bodies to verify reductions and removals is provided in the Reserve Verification Program Manual[1] and Section 8 of this protocol.

This protocol is designed to ensure the complete, consistent, transparent, accurate, and conservative quantification and verification of GHG emission reductions and carbon removals associated with a biochar project.[2]

[1] Available at http://www.climateactionreserve.org/how/verification/verification-program-manual/.
[2] See the WRI/WBCSD GHG Protocol for Project Accounting (Part I, Chapter 4) for a description of GHG reduction project accounting principles.

2 The GHG Reduction Project

2.1 Background

Biochar, the product of the heating of biomass at high temperatures in an oxygen-limited setting, is a carbon-dense material that has a growing list of beneficial uses, including as a soil amendment or as an additive for other agricultural, industrial, and commercial purposes. Although the soils of *Terra Preta de Indio* in the Amazon provide perhaps the most prominent evidence of the historical application of biochar to soils resulting in improved productivity—and a testament to the long-term stability of the carbon sequestered in biochar—evidence from around the globe points to the use and persistence of biochar and biochar-like materials at agricultural sites for thousands of years.[3] This protocol addresses the sequestration benefits related to the carbon contained in biochar, identifying the conditions that must be met for the potential for biochar to provide net climate benefits to be realized.

Biochar can provide not only highly durable carbon that remains out of the atmosphere for centuries if not millennia, but also a variety of potential ancillary greenhouse gas benefits, depending on how it is applied, such as reduced methane emissions from enteric fermentation when biochar is used as a livestock feed additive (Man *et al.* 2021) or reduced nitrous oxide emissions when applied to soils (Woolf *et al.* 2021). Although the Reserve recognizes such ancillary GHG outcomes are possible and often quite likely, the accounting of such benefits is currently not included in this protocol owing to the inability of the current certainty in the scale and scope of such benefits to allow them to be incorporated into a standardized quantification approach, especially in ways that lends itself to practical monitoring and verification. Thus, the ancillary GHG benefits from biochar will be considered for future updates to the protocol and/or may be accounted for by other offset protocols that may be able to address such benefits more effectively, such as the Reserve's Soil Enrichment Protocol.

2.2 Project Definition

For the purpose of this protocol, a biochar project is defined as the set of activities related to the diversion of biomass from "business as usual" (baseline) uses, its conversion into biochar, and its application to a durable use that results in the long-term storage of carbon. Biochar is defined here as the carbonaceous solid material resulting from the thermochemical conversion of biomass in an oxygen-limited environment.

Project activities are those activities that are necessary for the production and application of biochar in a way that produces net climate benefits relative to the baseline scenario. Three distinct phases comprise the scope of a biochar project under this protocol: 1) biomass acquisition, 2) biochar production, and 3) biochar application. No specific configuration is required with respect to the activities from each phase comprising a project. Rather, the combination of such activities must, as a whole, produce quantifiable climate benefits. Nevertheless, activities that are eligible for inclusion within a given project are limited as follows for each phase.

[3] Wiedner, K., & Glaser, B. (2015). Traditional use of biochar. In J. Lehmann, & S. Joseph (Eds.), *Biochar for environmental management – science, technology and implementation,* 2nd ed (pp. 15– 38) Routledge.

2.2.1 Biomass Acquisition

Eligible feedstocks for the production of biochar must be biomass that is a waste stream, by-product or residue from forest, agricultural, and other resource management industries (hereafter, waste and by-product biomass), or it must be biomass grown under certain limited conditions for the purpose of producing biochar (hereafter, purpose-grown biomass).

A positive list of eligible feedstocks, contained in a separate document called the Eligible Biochar Feedstocks List, is available on the Reserve's Biochar Protocol webpage. The list indicates feedstocks that are eligible for use under the protocol, their assumed baseline fate, and any additional environmental safeguards or other limits to the use of a given feedstock. In all cases, the use of any feedstock—and the characteristics of the resulting biochar—must also satisfy further requirements specified under this protocol pertaining to additionality (Section 3.4.1.1), regulatory compliance (Section 3.6), and environmental safeguards (Section 3.7).

A feedstock type may be included in the project when it appears on the eligibility list as follows:

- When the project is first submitted for listing;
- Between when a project is listed and when it undergoes its initial verification;
- When the project is resubmitted to renew a crediting period;
- At any point during a crediting period when a new feedstock type is added to the eligibility list.

If a feedstock that is not included on the list is being contemplated for inclusion in a project, that feedstock must be proposed to the Reserve for inclusion on the list. The Reserve may periodically review and update the Eligible Biochar Feedstocks List, at its sole discretion, to incorporate additional feedstock types and to ensure the list continues to effectively screens projects and associated feedstocks for the requirements outlined in this protocol. Project developers have 90 days from the date on which an updated list is released to submit a project that includes a removed feedstock. The project must still complete verification within its initial verification deadline, otherwise, the feedstock will be deemed ineligible for the project. Registered projects may continue to use feedstocks that are removed from the Eligible Biochar Feedstocks List for the duration of their current crediting period if they have previously verified and been issued credits for that feedstock or if they submit the verification that includes the removed feedstock, to the Reserve, within 12 months of the release of the updated list.

All feedstock sources must be clearly identified by the project developer as part of chain of custody tracking, including physical location (parcel, facility, etc.) of each source and the date the biomass was obtained by the biochar producer. For additional details regarding chain of custody information provided for each feedstock source, see Section 6.1.

2.2.2 Biochar Production

Biochar produced via pyrolysis, gasification, and other thermochemical conversion processes are eligible to the extent that the resulting biochar, as indicated by laboratory analysis, contains eligible levels of stable carbon, as further described in Sections 3.5 and 6.2. The intent is not to limit production process eligibility other than to those that are capable of meeting the requirements of this protocol, including demonstrating the long-term durability of the carbon in the biochar produced and any relevant regulatory and environmental requirements. This includes biochar generated during bioenergy production that is typically re-injected into the boiler furnace to be combusted but, under a project under this protocol, could be diverted so the biochar carbon remains sequestered and is put to another use.

Production processes must also adhere to all relevant environmental, health, and safety laws and regulations, as further described in Section 3.6.

2.2.3 Biochar Application

To be eligible under this protocol, the biochar produced as part of a project must be applied to an end use that ensures the long-term durability of the sequestered carbon. Energy production is not an eligible application of biochar, nor are applications for which storage is highly variable, uncertain, or is expected to be short-term in nature.

Similar to feedstocks, a positive list of eligible applications for biochar is provided as a separate document called the Eligible Biochar End Uses List. The list is available on the Reserve's Biochar Protocol webpage and indicates eligible biochar end uses, as well as any limits to their eligibility. The application of biochar under a project must also satisfy any further requirements specified in relation to additionality (Section 3.4.1.3), regulatory compliance (Section 3.6), and environmental safeguards (Section 3.7). Any end use being considered for inclusion in a project but not currently on the positive list must be proposed to the Reserve for inclusion on the list. The list of eligible end uses will be updated by the Reserve, and at the sole discretion of the Reserve, as needed over time. Only those end uses on the list at the time of verification may be included in the project.

An important end-use for biochar is the application to soils. When used in soils, the application must comply with all relevant laws and regulations, including those relating to allowable contents or composition of soil amendments. Furthermore, biochar being applied to soils must comply with the biochar properties standards identified in Section 6.4. Biochar may also be used in non-soil applications, including in construction materials or other uses that result in the long-term storage of carbon, as discussed further in Section 3.5, so long as such applications comply with all relevant legal requirements, environmental safeguards, and materials standards requirements under this protocol.

Demonstration of end-use application is performed via chain-of-custody tracking, as further described in Section 6.1. In instances where biochar is transferred to an entity that will subsequently transfer the biochar to an ultimate end user (e.g., a retail store selling bags of biochar for application to home gardens or a "mixer" adding biochar to other materials, such as compost or concrete, with a known ultimate end use), the end use may be reported based on the ultimate end use that may be reasonably assumed based on supporting evidence, such as marketing materials from the intermediate end user. Only those amounts of biochar for which chain-of-custody tracking is performed may be included for credit quantification purposes in Section 5.

2.3 The Project Developer

The "project developer" is an entity that has an active account on the Reserve, submits a project for listing and registration with the Reserve, and is ultimately responsible for all project reporting and verification. Under this protocol, the project developer is assumed to be the end user of the biochar since they are the entity responsible for providing for the long-term durability of the carbon sequestered in the biochar and, thus, the permanence of the credits being issued. For example, a farmer applying biochar to their soil as an amendment is, by default, assumed to be the project developer.

However, a project developer may be another entity involved with the project, such as a biochar producer or an entity coordinating the reporting and registration of a project, which may include the aggregation of several smaller producers, as long as that entity has a documented agreement that conveys the ownership of the resulting carbon credits from the end user to said entity. Such agreements may include but are not limited to signed contracts, as well as purchase orders or sales receipts acknowledging the transfer of ownership. Using the prior example, a biochar producer providing biochar to the farmer applying it to their soil may be the project developer if they are able to provide a documented agreement through which the project developer obtains ownership of the carbon credits associated with the carbon in the biochar. In addition to transferring the claim to the carbon credits generated by the project, such agreements must also contain an acknowledgement by the end user that they have been notified of the carbon project and that they are not otherwise claiming credits under any other carbon crediting program for the carbon sequestered in the biochar they are obtaining under the project.

In any event, the project developer, whether the end user or designee through agreement, must have clear ownership of the project's carbon removals. The project developer must also attest to such ownership by signing the Reserve's Attestation of Title form.[4]

[4] Attestation of Title form available at http://www.climateactionreserve.org/how/program/documents/.

3 Eligibility Rules

Projects that meet the definition of a GHG reduction project in Section 2.2 must fully satisfy the eligibility rules summarized here in order to register with the Reserve. The remainder of this section provides complete details of all eligibility rules.

Eligibility Rule I:	Location	→	*U.S. and Canada and their tribal lands and territories*
Eligibility Rule II:	Project Start Date	→	*No more than twelve months prior to project submission**
Eligibility Rule III:	Project Crediting Period	→	*Carbon removals may only be reported during the crediting period; the crediting period may be renewed*
Eligibility Rule IV:	Additionality	→	*Meet performance standard test(s)*
		→	*Exceed regulatory requirements*
Eligibility Rule V:	Permanence	→	*Biochar is applied to eligible end use that provides long-term storage of carbon*
Eligibility Rule VI:	Regulatory Compliance	→	*Compliance with all applicable laws*
Eligibility Rule VII:	Environmental and Social Safeguards	→	*Comply with specified safeguards*

**See Section 3.2 for exception for projects with start dates prior to the adoption of this protocol.*

3.1 Location

Only projects located in the United States and Canada, their territories, and on tribal/First Nation lands within each country are eligible to register with the Reserve. Under this protocol, all phases of sourcing, production, and end use of the biochar must occur in eligible jurisdictions. Project activities may occur on locations where activities from other carbon project types are occurring, as long as such projects are in good standing with the program in which they were or are enrolled. However, such project stacking is subject to prior approval from the Reserve and guidance for any adjustments that may be required of the biochar project to ensure additionality and overall eligibility, as well as to prevent double-counting of credits, as described in Section 3.4.3.1.

3.2 Project Start Date

The project start date is defined as the first date of the first instance of biochar being produced under the project.

To be eligible, the project must be submitted to the Reserve no more than twelve months after the project start date, unless the project is submitted during the first 12 months following the date of adoption of this protocol by the Reserve board (the Effective Date).[5] For a period of 12 months from the Effective Date of this protocol (Version 1.0), projects with start dates no more than 24 months prior to the Effective Date of this protocol are eligible. Specifically, projects with start dates on or after [Adoption Month Day+1, Year-2] are eligible to register with the Reserve if submitted by [Adoption Month Day, Year]. Projects with start dates prior to [Adoption Month Day, Year-2] are not eligible under this protocol. Projects may always be submitted for listing by the Reserve prior to their start date. For projects that are transferring to the Reserve from other offset registries, start date guidance can be found in the Reserve Offset Program Manual.

3.3 Project Crediting Period

The project "crediting period" defines the period of time over which a project's net carbon removals are eligible to be verified as CRTs. The crediting period for projects under this protocol is ten years, and is composed of multiple reporting periods that meet the requirements in Section 7.3. The initial project crediting period begins at the project start date regardless of whether sufficient monitoring data are available to verify carbon removals from the project. At the end of each crediting period for a project, the project developer may apply for eligibility under another crediting period. However, the project must meet all eligibility requirements of the most current version of the protocol at the time of such application. If a project developer wishes to apply for eligibility under an additional crediting period, they must re-submit a project submittal form within six months of the end date of the current crediting period.

A project may be eligible for additional crediting periods even if the project has failed to maintain continuous reporting up to the time of applying for a second crediting period, provided the project developer elects to take a zero-credit reporting period for any period for which continuous reporting was not maintained.[6] Any additional crediting period shall begin on the day following the end date of the initial crediting period.

The Reserve will cease to issue CRTs for carbon removals if at any point in the future, the production and/or use of biochar becomes legally required, as defined by the terms of the legal requirement test (see Section 3.4.2). Thus, the Reserve will issue CRTs for carbon removals quantified and verified according to this protocol for ten-year crediting periods after the project start date, or until the project activity is enforced by law.

3.4 Additionality

The Reserve registers only projects that yield surplus GHG reductions that are additional to what would have occurred in the absence of a carbon offset market.

Projects must satisfy the following tests to be considered additional:

1. The performance standard test
2. The legal requirement test

[5] Projects are considered submitted when the project developer has fully completed and filed the appropriate Project Submittal Form, available at http://www.climateactionreserve.org/how/program/documents/.
[6] See zero-credit reporting period guidance and requirements in the Reserve Offset Program Manual, http://www.climateactionreserve.org/how/program/program-manual/.

3.4.1 The Performance Standard Test

Projects pass the performance standard test by meeting a performance threshold, i.e., a standard of performance established by this protocol and applicable as described below to all biochar projects. A separate performance standard test is provided for each phase of a project. A project must meet the performance threshold identified below for each phase for the project to meet the overall performance standard test

3.4.1.1 Biomass Acquisition

For the biomass acquisition phase, separate performance thresholds are identified for waste and by-product biomass and for purpose-grown biomass.

The performance threshold for waste and by-product biomass is based on the common fate of such biomass. Waste and by-product biomass is, by definition, not put to productive uses and is eligible under this protocol if it typically has short lifespans before the carbon it contain is released into the atmosphere, either via combustion (e.g., logging slash piled and burned) or decomposition (e.g., manure spread on fields). As such, the production and use of biochar derived from such feedstocks can produce net carbon removals relative to the baseline, as determined in Section 5, provided the project meets all other eligibility requirements under this protocol. This includes biochar produced as a by-product during bioenergy generation process in which such biochar is prevented from being reinjected into the boiler furnace and combusted. Projects using waste and by-product feedstocks pass the performance standard test for the biomass acquisition phase if the following conditions are met:

1. The feedstocks being diverted under the project must be on the Biochar Feedstocks Eligibility List, as described in Section 2.2.1.

2. The project developer must be able to characterize the typical fate of the project feedstocks, considering the local conditions and context of the project, to demonstrate that the source biomass was diverted from uses consistent with the assumed business as usual fate of the feedstock, as indicated in the Biochar Feedstocks Eligibility List.

The performance standard test for waste and by-product biomass is applied each reporting period. The basis for the performance standard test will be re-evaluated periodically by the Reserve to assess its ongoing validity, with modifications made as necessary to ensure the additionality of all projects in relation to the acquisition of waste and by-product feedstocks.

Purpose-grown biomass is assumed to generate net carbon removals under this protocol to the extent quantified under Section 5 when two conditions are met in relation to the context in which they are cultivated:

1. They must be acquired from either marginal cropland locations or from reclaimed mining sites. The use of an area for the cultivation of biomass used in biochar production may lead to increased GHG emissions beyond the project boundaries if land use changes increase elsewhere (i.e., activity-shifting leakage). For example, the cultivation of biomass for biochar production on lands where commodity crops were cultivated may result in increases in commodity crop production elsewhere, including potentially via conversion of previously non-cultivated lands. For the purposes of this protocol, marginal cropland is land not identified as prime farmland in the US or Canada based on standardized definitions and spatial delineations established by the US Department of

Agriculture – Natural Resources Conservation Service[7] and the Agriculture and Agri-Food Canada,[8] respectively.

In addition to being produced on marginal croplands or reclaimed mining sites, purpose-grown biomass must not be acquired from sites that, within the three years prior to its use for supplying biomass for biochar production under the project, underwent a land use change or were converted from a vegetation type with a higher carbon-density. Furthermore, the project developer must demonstrate that a waste management plan is in place that will limit emissions associated with anaerobic decomposition that may occur while the purpose-grown biomass is being stored prior to being transferred for conversion to biochar.

2. They must be grown under conditions whereby there is little to no carbon debt associated with the biomass when it is harvested to produce biochar, excluding activity-shifting leakage and feedstock production-related emissions, which are otherwise addressed in Section 3.4.1.2 and Section 5.3, respectively. In other words, the harvesting of the biomass must not result in the loss of carbon in the cultivated crop that is not typically recovered by regrowth within a year or the depletion of soil organic carbon in the near-term. For example, biomass from perennial grass species that are grown and harvested with minimal soil disturbance, thus preventing the depletion of soil organic carbon stocks, have no carbon debt in this regard when entering as a feedstock for biochar production. Project developers using purpose-grown biomass must use a type included on the Biochar Feedstocks Eligibility List. They must also identify the harvest conditions associated with the project feedstocks and be able to describe how such conditions, including within the potential context of annual harvesting, have minimal or no negative impacts on soil organic carbon over a time scale of several years.

The performance standard test for purpose-grown biomass source location is applied each reporting period. The basis for this performance standard test will be re-evaluated periodically by the Reserve to assess its ongoing validity, with modifications made as necessary to ensure the additionality of all projects in relation to the acquisition of purpose-grown biomass.

3.4.1.2 Biochar Production

The performance standard for biochar production is based on the effect of the incentive of the issuance of carbon credits to foster the production and use biochar in ways that are eligible under this protocol and provide net climate benefits.

The production of biochar in the US and Canada faces numerous impediments. Despite the known benefits already demonstrated for biochar, including in relation to agricultural soils and productivity, the biochar market has experienced highly constrained growth to date, with companies often struggling to maintain production over time. This is due in part to uncertain demand for biochar, feedstock supply chain inconsistency, and high sales prices typically required to cover production costs (Elias et al., 2022; Thengane et al., 2021). Emphasizing the industry's nascent status is the lack of a commodity market for biochar. In the absence of the incentive provided by carbon markets, muted biochar production levels would likely remain over the near term. However, revenue from carbon credit sales has been anticipated by biochar producers to improve the viability of their operations (Thengane et al., 2021). Credit sales have also been shown through economic analysis to provide improved and often positive rates of

[7] SSURGO soil survey data, available at https://websoilsurvey.nrcs.usda.gov/app/
[8] National Soil Database, available at https://sis.agr.gc.ca/cansis/nsdb/index.html

return to biochar production operations (Elias et al., 2022). Carbon crediting opportunities that have emerged in recent years have already spurred growth in the market[9] as carbon revenues provide more favorable cost-revenue profiles to participating producers.

As a result of these conditions, a project meets the performance standard test for biochar production to the extent such production and its associated end use meet all other eligibility requirements and produce net carbon removals, as quantified according to Section 5.

The performance standard test for biochar production is applied at the time a project applies for initial registration with the Reserve, as well as at the start of any additional crediting periods. The basis for the performance standard test will be re-evaluated periodically by the Reserve to assess its ongoing validity, with modifications made as necessary to ensure the additionality of new projects and projects seeking to renew their crediting period. Nevertheless, projects that pass the performance standard test, whether at the time of initial registration or when renewing their crediting period, remain eligible in this regard throughout their crediting period.

3.4.1.3 Biochar Application

The performance threshold for the biochar application phase is based on the durability of biochar produced under a project in the context of the end use to which it is applied. Biochar produced under this protocol must not only be of sufficient quality to provide for the potential long-term sequestration of the carbon it contains, as described in relation to permanence in Section 3.5. It must also be applied in an end use that provides for the realization of that potential for long-term sequestration. As such, projects meet the performance standard for biochar application by employing end uses identified on the Biochar End Uses Eligibility List, as previously described in Section 2.2.3.

3.4.2 The Legal Requirement Test

All projects are subject to a legal requirement test to ensure that the GHG reductions and removals achieved by a project would not otherwise have occurred due to federal, state, or local regulations, or other legally binding mandates.

To satisfy the legal requirement test, the production of biochar and its application in an eligible end use must not be legally mandated. Project developers must submit a signed Attestation of Voluntary Implementation form[10] prior to the commencement of verification activities each reporting period that is verified (see Section 8). In addition, the project's Monitoring Plan (Section 6) must include procedures that the project developer will follow to ascertain and demonstrate that the project at all times passes the legal requirement test. If the production and use of biochar becomes legally required after a project has initiated, carbon removals may be reported to the Reserve up until the date that the requirement for such production and use comes into effect and is enforced.

3.4.3 Ecosystem Services Payment Stacking

When multiple ecosystem services credits or payments are sought for a single activity on a single piece of land or facility, with some temporal overlap between the different credits or payments, it is referred to as "credit stacking" or "payment stacking," respectively (4). Under this protocol, credit stacking is defined as receiving both offset credits and other types of mitigation credits for the same activity on spatially overlapping areas (i.e., in the same acre or the same

[9] See https://www.cdr.fyi/

[10] Attestation forms are available at http://www.climateactionreserve.org/how/program/documents/.

facility or operations) associated with any phase of a biochar project. Mitigation credits are any instruments issued for the purpose of offsetting the environmental impacts of another entity, such as emissions of GHGs, removal of wetlands or discharge of pollutants into waterways, to name a few. Payment stacking is defined as receiving payments for a best management or conservation practice that is also funded by the government or other parties via grants, subsidies, payment, etc., on the same land or in the same facility or set of operations.

Any type of conservation or ecosystem service payment received for activities on the project area must be disclosed by the project developer to the verification body and the Reserve on an ongoing basis. Failure to disclose such payments may result in project ineligibility.

3.4.3.1 Credit Stacking

The Reserve has identified only one type of mitigation credit market opportunity that needs to be assessed as part of the eligibility of a biochar project. Activities attributable to a given biochar project may spatially and temporally overlap with the activities attributable to other carbon or GHG mitigation project types, such as improved forest management projects or projects registering under the Reduced Emissions from Megafires (REM) Forecast Methodology with the Reserve's Climate Forward Program. Stacking of different project types may impact project eligibility if the additionality of an individual project is affected, or if it results in conflicting claims of credit ownership or double-counting of credits. For example, biochar for which credits are sought under this protocol would not be allowed to be applied to soils on fields enrolled in a carbon project under another protocol for which increases in soil organic carbon attributable to biochar amendments are credited. On the other hand, credit stacking between a biochar project and a project registered under the REM Forecast Methodology may be allowed as long as additionality is not impacted for either project as a result of such stacking and the carbon sequestered in the biomass removed from the forest during fuel treatments and stored in harvested wood products is not accounted for, thereby avoiding potential double-counting.

Any intended project stacking must be disclosed to the Reserve when the project is submitted for listing and prior to any time such stacking occurs during a project's crediting period, at which time Reserve staff will determine if stacking is approved and will provide guidance on any further adjustments that may be required of the project to ensure additionality and all other eligibility requirements can be met, and to avoid double-counting of credits.

3.4.3.2 Payment Stacking

The Reserve has identified one general type of payment that supports the activities being credited under this protocol. These types of payments are known as "enhancement" payments.

Enhancement payments provide financial assistance to landowners to implement discrete conservation practices that address natural resource concerns and deliver environmental benefits. An example of relevant enhancement payments are cost-share payments administered by the NRCS Environmental Quality Incentives Program (2014 Farm Bill). However, since multiple phases are required to undertake a biochar project and enhancement payments tend to only address a single project phase, such payments are not considered to impact project additionality and are allowed to be pursued by project developers.

Nevertheless, because every available enhancement payment is not comprehensively addressed by the protocol at this time, the project developer must still disclose any such payments to the verifier and the Reserve on an ongoing basis.

3.5 Permanence

The Reserve requires that credited reversible GHG reductions and removals be effectively "permanent" in order to serve as valid offset credits. For purposes of this protocol, permanence relates to the durability of the biochar on a 100-year basis. A tonne of biochar produced and utilized is considered permanent, and credited as such, based on the relative amount of the tonne that remains sequestered over the 100-year period. For biochar applications that are not anticipated to maintain sequestered carbon for the full 100-year term, the average amount of each tonne anticipated to be sequestered throughout the 100 year period will be credited. For each project, the permanence of the biochar produced is based on the end use(s) of the biochar. The quantification approach outlined in Section 5 relies on the application of default permanence factors to estimate the proportion of carbon remaining sequestered based on the end use(s) of the project biochar. Only those end uses for which there are reasonable levels of certainty about the long-term fate of the applied biochar and the carbon it contains are eligible for crediting under this protocol and included in the Eligible Biochar End Uses List.

Regardless of the end use, the biochar produced under a project must have a demonstrated level of potential for long-term durability commonly associated with biochar, resulting from the highly stable molecular structure of biochar established during the thermochemical conversion process. This durability is evidenced by biochar having a ratio of hydrogen to organic carbon ($H:C_{org}$) of less than 0.7, based on the upper bound of the confidence interval determined for $H:C_{org}$ via sampling and laboratory analysis, as further described in Section 6.4. If ongoing sampling and laboratory analysis results in an updated $H:C_{org}$ value above 0.7, biochar produced under the project will be ineligible (i.e., no CRTs issued) for that period of time until additional sampling and analysis results lower the value to or below 0.7.

Beyond long-term degradation of biochar, the primary risk of carbon in biochar being reversed and released into the atmosphere is from combustion. As described in Section 2.2, combustion for energy production purposes is not an eligible end use for biochar under this protocol. Additionally, since only biochar that is verified to have been applied to eligible reported end uses by the project developer may be credited, any loss of carbon associated with combustion after biochar is produced but prior to end use application is already accounted for via project reporting and quantification requirements. Thus, the remaining combustion risk is post-application, when the risk is negligible.

3.6 Regulatory Compliance

Project developers must attest that project activities do not cause material violations of applicable laws (e.g., air, water quality, safety, etc.). The determination of regulatory compliance must take into consideration processes and outcomes related to activities accounted for under the chain of custody tracking requirements (Section 6.3), i.e., from the time feedstocks are diverted (waste/by-product biomass) or harvested (purpose-grown feedstocks), through when biochar is delivered to the end user. To satisfy this requirement, project developers must submit a signed Attestation of Regulatory Compliance form[11] prior to the commencement of verification activities each time the project is verified.

Project developers are also required to disclose in writing to the verifier any and all instances of legal violations – material or otherwise – caused by the project activities. A violation would be considered to be "caused" by project activities if it can be reasonably argued that the violation

[11] Attestation forms are available at http://www.climateactionreserve.org/how/program/documents/.

would not have occurred in the absence of the project activities. If there is any question of causality, the project developer shall disclose the violation to the verifier.

If a verifier finds that project activities have caused a material violation, then CRTs will not be issued for GHG reductions that occurred during the period(s) when the violation occurred. Individual violations due to administrative or reporting issues, or due to "acts of nature," are not considered material and will not affect CRT crediting. However, recurrent administrative violations directly related to project activities may affect crediting. Verifiers must determine if recurrent violations rise to the level of materiality. If the verifier is unable to assess the materiality of the violation, then the verifier shall consult with the Reserve.

3.7 Environmental and Social Safeguards

This protocol is intended to credit for the carbon removals associated with the production of biochar and long-term maintenance of the carbon it contains out of the atmosphere. All three phases of a biochar project have the potential to occur within or interact with natural and working lands and thus have the potential to degrade ecosystem services such as water quality, biodiversity, and air quality. This protocol relies primarily on the feedstock and end use eligibility positive lists (described in Section 2.2.1) and existing laws and regulatory programs (described in Section 3.6) to ensure community standards for such issues are met. While the positive eligibility lists provide specific limits with respect to allowable conditions for biomass sourcing and eventual biochar application, the regulatory compliance requirements in the preceding section set out guidance for ensuring no legal standards or obligations are violated, including laws relating to broader non-GHG impacts of projects. The obligation to comply with relevant legal requirements includes those laws and regulations pertaining to worker health and safety. Additionally, projects involving field-based biochar production must provide a safety plan outlining procedures and precautions meant to ensure worker safety during operations if such procedures are not already required by law.

When registering a project, the project developer must attest that the project was in material compliance with all applicable laws and regulations. Recognizing that environmental regulations are not consistent across jurisdictions, each project must test for the properties and chemical composition of biochar produced under the project, as outlined in Section 6.4.2, and meet standards and limits relevant to the end use to which the biochar is applied. For those jurisdictions for which limits on chemical composition are not specified, biochar produced under a project must comply with the basis for limits referenced for each end use in the Eligible Biochar End Uses List.

Feedstocks used for the production of biochar under a project may contain mineral additives, such as ash, lime or rock minerals. Feedstocks may similarly contain contaminants. However, all biochar must be tested for chemical composition as specified in Section 6.4.2, including for organic and inorganic contaminants, unless the applied end use prevents environmental exposure of such contaminants and the project developer is able to demonstrate that no relevant laws or regulations otherwise limit such contaminants in that end use.

[**WG Question**: Are there specific conditions (certain types of feedstocks or contaminants in feedstocks; certain biochar production processes/technologies) for which testing for biochar contaminants like PCBs, PAHs, or dioxins/furans should be required?]

Although biochar projects are expected to be developed in ways that provide a variety of environmental benefits, the project developer should nonetheless take all reasonable

precautions to ensure no broader harms are caused by the project. Furthermore, the Reserve urges project developers to describe any significant impacts (positive or negative) that their GHG projects will have on other environmental issues such as air and water quality, endangered species and natural resource protection, and environmental justice. Although such reporting is optional, the intent with this guidance is to encourage project developers to better highlight the ways in which their projects positively or negatively affect such goals and, where potential negative environmental and socio-economic impacts are identified, describe the steps that have been, or will be, taken to mitigate and/or monitor them. The Reserve provides an SDG Reporting Tool on its website[12] to facilitate the reporting of co-benefits in relation to the United Nation's Sustainable Development Goals.

[12] https://www.climateactionreserve.org/how/program-resources/documents/

4 The GHG Assessment Boundary

The GHG Assessment Boundary delineates the GHG sources, sinks, and reservoirs (SSRs) that must be assessed by project developers in order to determine the net change in emissions caused by a biochar project.

Figure 4.1 illustrates all relevant GHG SSRs associated with biochar project activities and delineates the GHG Assessment Boundary. GHG SSRs are included for assessment where the differences between project and baseline quantification are likely to be significant.

Table 4.1 provides greater detail on each SSR and justification for the inclusion or exclusion of certain SSRs and gases from the GHG Assessment Boundary.

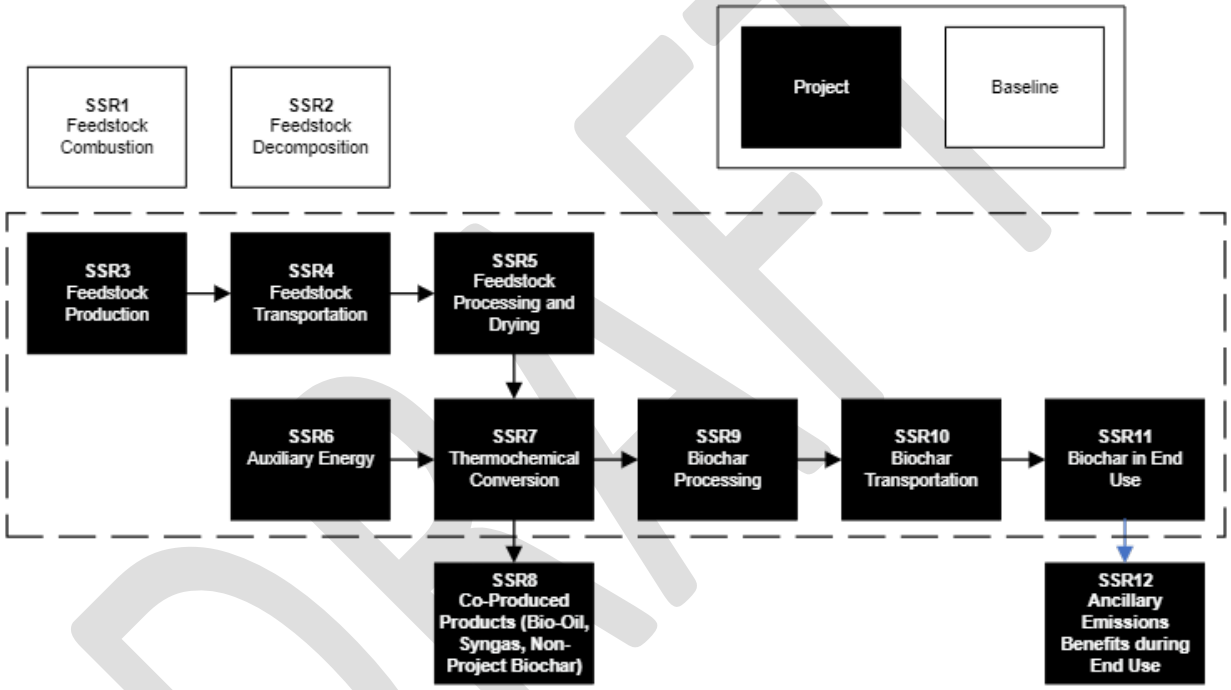

Figure 4.1. General illustration of the GHG Assessment Boundary. SSRs within the dashed lines are included in project accounting.

Table 4.1. Description of all Sources, Sinks, and Reservoirs

SSR	Source Description	Gas	Included (I) or Excluded (E)	Baseline (B) or Project (P)	Justification/Explanation
1	Feedstock Combustion	CO_2 CH_4	E	**Baseline:** Assumed to be zero, thus effectively excluded **Project:** N/A	Although the combustion of biomass under the baseline scenario would result in GHG emissions, those emissions are not quantified under this protocol on a conservative basis, as described in Section 5.1.
2	Feedstock Decomposition	CO_2 CH_4	E	**Baseline:** Assumed to be zero, thus effectively excluded **Project:** N/A	Although the decomposition of biomass under the baseline scenario would result in GHG emissions, those emissions are not quantified under this protocol on a conservative basis, as described in Section 5.1.
3	**Feedstock Production (Fossil Fuels, Fertilizer)**	CO_2	I (conditionally)	**Baseline:** N/A **Project:** Calculated from chain-of-custody or other documentation and standardized emissions factors	Emissions associated with the production of waste and by-product feedstocks is not required to be accounted for under this protocol since such emissions would have occurred even in the absence of the project. However, the cultivation of purpose-grown biomass to provide a feedstock supply for biochar production can result in significant emissions that would not have occurred if not for the project. Such emissions are associated with fossil fuel consumption from equipment and fertilizer use during cultivation and harvest.
4	**Feedstock Transportation**	CO_2	I	**Baseline:** N/A **Project:** Calculated from chain-of-custody or other documentation and standardized emissions factors	Emissions from the transportation of feedstocks has the potential to be significant, in particular when biochar is produced at a location not in close proximity to the biomass source.

SSR	Source Description	Gas	Included (I) or Excluded (E)	Baseline (B) or Project (P)	Justification/Explanation
5	**Feedstock Processing and Drying (Electricity, Fossil Fuels)**	CO_2	I	**Baseline:** N/A **Project:** Calculated from electricity and fossil fuel consumption records and standardized emissions factors	When fossil fuels are combusted or electricity is consumed to process biomass prior to conversion to biochar, significant emissions can be generated.
6	**Auxiliary Energy (Electricity, Fossil Fuels)**	CO_2	I	**Baseline:** N/A **Project:** Calculated from electricity and fossil fuel consumption records and standardized emissions factors	Electricity use and fossil fuel combustion to support the thermochemical conversion process can lead to significant emissions.
7	**Thermochemical Conversion**	CH_4	I (conditionally)	**Baseline:** N/A **Project:** Calculated from reported biochar output and standardized emissions factors by biochar production process	For thermochemical conversion processes that do not recover or combust methane, such emissions may be significant and must be accounted for.
8	**Co-Produced Products (Bio-Oil, Syngas, Non-project Biochar)**	CO_2 CH_4 N_2O	E	**Baseline:** N/A **Project:** N/A	Although materials co-produced at the same facility as project biochar may have emissions or sequestered carbon associated with their use, such emissions and carbon are excluded from the scope of project accounting since baseline emissions affiliated with such products are also not accounted for under this protocol.

SSR	Source Description	Gas	Included (I) or Excluded (E)	Baseline (B) or Project (P)	Justification/Explanation
9	**Biochar Processing (Electricity, Fossil Fuels)**	CO_2	I	**Baseline:** N/A **Project:** Calculated from electricity and fossil fuel consumption records and standardized emissions factors	Electricity use and fossil fuels combustion to process biochar can produce significant emissions and must be accounted for, whether such processing is performed by the biochar producer or an entity acting as an intermediary between the biochar producer and the ultimate end user(s).
10	**Biochar Transportation**	CO_2	I (conditionally)	**Baseline:** N/A **Project**: Calculated from chain-of-custody or other documentation and standardized emissions factors	Emissions from the transportation of biochar has the potential to be significant, in particular when biochar is produced at a location not in close proximity to the biomass source. For certain end uses for which biochar serves as a substitute for another material, such transportation emissions are excluded from project accounting. Such applications are identified in the Eligible Biochar End Uses List.
11	**Biochar in End Use**	CO_2	I	**Baseline:** N/A **Project:** Calculated from chain-of-custody documentation, laboratory analyses results, and standardized factors	Carbon sequestered in a highly stable molecular structures within biochar is the primary climate benefit accounted for under this protocol.
12	**Ancillary Emissions Benefits during End Use**	CO_2 CH_4 N_2O	E	**Baseline:** N/A **Project**: N/A	Although ancillary GHG benefits may be produced when biochar is applied to certain end uses under appropriate circumstances, such benefits are not accounted for under this protocol at this time.

5 Quantifying Carbon Removals

Carbon removals from a biochar project are quantified by comparing actual project emissions and sequestered carbon to the calculated baseline emissions and sequestered carbon. Baseline emissions and carbon stocks are an estimate of the GHG emissions from sources within the GHG Assessment Boundary (see Section 4) that would have occurred, as well as the carbon that would remain sequestered, in the absence of the project. Project emissions and carbon stocks are actual GHG emissions and sequestered carbon from sources, sinks, and reservoirs within the GHG Assessment Boundary. The difference between baseline and project emissions and baseline and project carbon stocks serves as the basis for the project's total net carbon removals (Equation 5.1).

Equation 5.1. Calculating net carbon removals

$$\boldsymbol{CR = (BE - PE) - (BC - PC) - LE}$$

Where,			Units
CR	=	Total carbon removals for the reporting period	tCO_2e
BE	=	Total baseline emissions for the reporting period, from all emission-based SSRs in the GHG Assessment Boundary Baseline emissions are assumed to be zero for all projects (refer to Section 5.1).	tCO_2e
PE	=	Total project emissions for the reporting period, from all SSRs in the GHG Assessment Boundary (as calculated in Section 5.2)	tCO_2e
BC	=	Total carbon sequestered in the baseline scenario for the reporting period. Carbon stocks are assumed to be zero for all projects (refer to Section 5.1).	tCO_2e
PC	=	Total carbon sequestered by the project for the reporting period	tCO_2e
LE	=	Emissions associated with leakage from projects required to report such emissions (see Section 5.3)	tCO_2e

The Reserve provides a Biochar CRT Calculation Tool, a spreadsheet-based quantification tool, for use with all projects to facilitate the calculations required under this protocol. Carbon removals must be quantified and verified on at least an annual basis. Project developers may choose to quantify and verify carbon removals on a more frequent basis if they desire. The length of time over which carbon removals are periodically quantified and verified is called the "reporting period," as further described in Section 7.3.

Note that global warming potential (GWP) values in the equations in this section are specified as variables. The GWP values used are based on those currently required programmatically by the Reserve. At the time of initial adoption, the 100-year GWP values specified for use under the Reserve's protocols are from the Fifth Assessment Report (AR5) from the Intergovernmental Panel on Climate Change. GWPs applicable at any given time are incorporated into the Biochar CRT Calculation Tool, which will be updated any time the Reserve updates its programmatic GWP values.

5.1 Quantifying the Baseline

The baseline approach employed under this protocol assumes no emissions occur under the baseline. Although there would be emissions expected to be associated with the fate of the feedstock biomass in the absence of the project, it is conservative to assume a value of zero for the variable *BE* in Equation 5.1.

Although some carbon in eligible waste and by-product feedstock types may be sequestered under the baseline scenario, the vast majority of such carbon combusts or decomposes over relatively short time scales. Any remaining carbon would be insignificant relative to those emissions from combustion or decomposition. Since such emissions are assumed to be zero under this protocol, baseline carbon stocks (variable *BC* in Equation 5.1) may also be assumed to have a value of zero while maintaining a conservative baseline overall. As such, there is no requirement to account for baseline carbon stocks.

5.2 Quantifying Project Emissions and Carbon Stocks

Project emissions and carbon stocks are actual GHG emissions and removals that occur within the GHG Assessment Boundary as a result of the project activity. Project emissions must be quantified every reporting period on an *ex post* basis.

5.2.1 Calculating Project Emissions

Estimates of GHG emissions associated with the project are based on the sources included in the GHG assessment boundary for the project, as identified in Table 4.1. Depending on the configuration of project phases, these may include emissions from the transportation of feedstocks, drying and processing of feedstocks, use of auxiliary fuels and/or electricity during biochar production, and processing of the outputs from thermochemical conversion. The total project emissions for a reporting period are based on the calculation described in Equation 5.2 and are entered into Equation 5.1 as *PE*.

Equation 5.2. Project emissions

$$\boldsymbol{PE = PE_{FProd} + PE_{FT} + PE_{FProc} + PE_{AE} + PE_{PY} + PE_{BP} + PE_{BT}}$$

Where,			Units
PE	=	Total emissions from the project for the reporting period	tCO_2e
PE_{FProd}	=	Emissions from production of feedstocks for the reporting period (see Equation 5.3)	tCO_2e
PE_{FT}	=	Emissions from transportation of feedstocks for the reporting period (see Equation 5.4)	tCO_2e
PE_{FP}	=	Emissions from processing and drying of feedstocks at biochar production facility for the reporting period (see Equation 5.5)	tCO_2e
PE_{AE}	=	Emissions from auxiliary energy use during biochar production for the reporting period (see Equation 5.6)	tCO_2e
PE_{PY}	=	Emissions from pyrolysis under biochar production conditions that do not recover or combust non-CO_2 GHGs for the reporting period (see Equation 5.8)	tCO_2e
PE_{BP}	=	Emissions from processing of biochar for the reporting period (see Equation 5.9)	tCO_2e
PE_{BT}	=	Emissions from transportation of biochar to end use location for the reporting period, when applicable (see Equation 5.10)	tCO_2e

If emissions from fossil fuel combustion or electricity from any of the emissions sources described below are attributable to a facility rather than an individual source (e.g., feedstock processing, auxiliary emissions), the emissions may be calculated and reported under one of the sources. For example, if a biochar production facility has fossil fuel combustion and electricity consumption data for the facility as a whole rather than separately for the feedstock

processing, auxiliary energy, and biochar processing processes, the project developer may enter the facility-level data in the feedstock processing emissions section of the Biochar CRT Calculation Tool and provide a corresponding description of the facility-wide nature of the data in the project design document.

5.2.1.1 Feedstock Production Emissions

When biomass grown for the purpose of providing a feedstock source for biochar production is used by a project, the emissions associated with the production of that crop are required to be accounted for, as described in Equation 5.3, since such emissions would not have occurred if not for the project taking place. For the purposes of this protocol, default emissions factors are provided for the quantification of feedstock production emissions, with emissions based on the total area used to cultivate the biomass harvested and delivered for biochar production (e.g., acreage of field). The intent is to account for emissions associated with the operation of fossil fuel-powered equipment used for the cultivation and harvesting of such biomass, as well as emissions associated with fertilizer applications. Standardized emissions factors, based on area and type of crop, are provided in the Biochar CRT Calculation Tool. Production emissions are not quantified for feedstocks that are waste or by-product materials.

Equation 5.3. Feedstock production emissions

$$PE_{FProd} = \sum_{F} A_F \times EF_F$$

Where,

			Units
PE_{FProd}	=	Total emissions from production of purpose-grown biomass feedstocks for the reporting period	tCO_2e
A_F	=	Area harvested for purpose-grown biomass feedstock *F*	acres
EF_F	=	Emissions factor for production of purpose-grown biomass feedstock type *F*	tCO_2e/acre

5.2.1.2 Feedstock Transportation Emissions

Emissions from the transport of feedstock materials to production are determined using Equation 5.4 and are entered as PE_{FT} in Equation 5.1. Transportation emissions may be calculated based on fuel records, if available, or on the transportation mode, mass of feedstock transported, and distance traveled. Default emissions factors for either approach are provided in the Biochar CRT Calculation Tool. Projects producing biochar at the site of the feedstock source are not required to calculate feedstock transportation emissions.

Equation 5.4. Feedstock transportation emissions

Equation 5.4a: Calculation of feedstock transportation emissions based on fuel records

$$PE_{FT} = \sum_{ff} V_{ff} \times EF_{ff}$$

Where,

			Units
PE_{FT}	=	Total emissions from transportation of feedstocks for the reporting period	tCO_2e
V_{ff}	=	Volume of fuel type *ff* consumed	unit of volume
EF_{ff}	=	Emissions factor for fuel type *ff*	tCO_2e/unit of volume

Equation 5.4b: Calculation of feedstock transportation emissions based on transportation type, mass of feedstock transported, and distance traveled

$$\boldsymbol{PE_{FT} = \sum_{tr} M_{tr} \times D_{tr} \times EF_{tr}}$$

Where,			Units
M_{tr}	=	Mass of feedstock transported by transportation type *tr*	tonnes
D_{tr}	=	Total distance feedstocks were transported using transportation type *tr* for the reporting period	km
EF_{tr}	=	Emissions factor for transportation type *tr*	tCO_2e/tonne-km

5.2.1.3 Feedstock Processing Emissions

Processes used to prepare feedstocks for thermochemical conversion may require the use of energy. The emissions associated with such energy use must be accounted for, whether occurring in the field or at a production facility. The preparation of feedstocks for biochar production may involve fossil fuel combustion or the use of electricity. Emissions from feedstock processing are determined using Equation 5.5.

Equation 5.5. Feedstock processing emissions

$$\boldsymbol{PE_{FProc} = \left(PE_{FProc,FC} + PE_{FProc,EC}\right)}$$

Where,			Units
PE_{FProc}	=	Total emissions from processing of feedstocks for the reporting period	tCO_2e

And, for calculation of emissions from fossil fuel combustion:

Either based on fuel records,

$$\boldsymbol{PE_{FProc,FC} = \sum_{ff} FC_{FProc,ff} \times EF_{ff}}$$

Where,

$PE_{FProc,FC}$	=	Emissions associated with the combustion of fuels for the processing of feedstocks in preparation for biochar production	tCO_2e
$FC_{FProc,ff}$	=	Total mass or volume of fuel type *ff* consumed for the processing of feedstocks for the reporting period	mass or volume unit
EF_{ff}	=	Emissions factor for the fuel type *ff*	tCO_2e/(mass or volume unit)

Or based on processing type and mass of feedstocks processed,

$$\boldsymbol{PE_{FProc,FC} = \sum_{p} M_{p} \times EF_{FC,p}}$$

Where,

M_{fp}	=	Total mass of feedstocks processed using processing type *fp*	tonnes
$EF_{FC,fp}$	=	Emissions factor for fossil fuel consumption using processing type *fp*	tCO_2e/tonne

And for calculation of emissions from electricity consumption:

Either based on electricity consumption records,

$$PE_{FProc,EC} = \sum_{F} EC_{FProc,F} \times EF_{EC}$$

Where,

$PE_{FProc,EC}$	=	Emissions associated with the use of electricity for the processing of feedstocks in preparation for biochar production	tCO_2e
$EC_{Fproc,F}$	=	Total amount of electricity consumed for the processing of feedstock type *F* for the reporting period	kwh
EF_{EC}	=	Emissions factor for electricity at the feedstock processing location[13]	tCO_2e/kwh

Or based on processing type and mass of feedstocks processed,

$$PE_{FProc,EC} = \sum_{p} M_p \times EF_{EC,p}$$

Where,

M_{fp}	=	Total mass of feedstocks processed using processing type *fp*	tonnes
$EF_{EC,fp}$	=	Emissions factor for electricity consumption using processing type *fp*	tCO_2e/tonne

5.2.1.4 Auxiliary Energy Emissions

For some projects, the combustion of fossil fuels or the use of electricity is required during the process of thermochemically converting feedstocks into biochar. When such energy is used, the associated emissions must be accounted for under this protocol based on Equation 5.6.

Equation 5.6. Auxiliary energy emissions

$$PE_{AE} = \left(PE_{AE,FC} + PE_{AE,EC}\right) \times AF$$

Where,

			Units
PE_{AE}	=	Total emissions from auxiliary energy used to produce biochar for the reporting period	tCO_2e
AF	=	Proportional adjustment to emissions to account for only project-related emissions (see Equation 5.7)	%

And

$$PE_{AE,FC} = \sum_{ff} FC_{AE,ff} \times EF_{ff}$$

Where,

$PE_{AE,FC}$	=	Emissions associated with the combustion of fuels to facilitate the production of biochar	tCO_2e
$FC_{AE,ff}$	=	Total mass or volume of fuel type *ff* consumed for biochar production purposes for the reporting period	mass or volume unit
EF_{ff}	=	Emissions factor for the fuel type *ff*	tCO_2e/(mass or volume unit)

And

$$PE_{AE,EC} = EC_{AE} \times EF_{EC}$$

Where,

[13] Based on factors from the Emissions & Generation Resource Integrated Database (eGRID) (US) or *Canada's National Inventory Report 1990-2020: Greenhouse Gas Sources and Sinks in Canada* for grid-connected electricity and from the US EPA GHG Emissions Hub for non-grid-connected electricity

$PE_{AE,FC}$	=	Emissions associated with the use of electricity to facilitate the production of biochar	tCO_2e
EC_{AE}	=	Total amount of electricity consumed for biochar production purposes for the reporting period	kwh
EF_{EC}	=	Emissions factor for electricity at the feedstock processing location[14]	tCO_2e/kwh

Where biochar is not the sole product of the facility where it is produced for the project, auxiliary emissions attributable to the biochar project are determined on a proportional basis relative to the total product output generated by the project facility, resulting in the adjustment factor (*AF*) applied in both Equation 5.6 and Equation 5.8. A common metric based on the energy content of all relevant facility outputs is employed to determine the combined output of the facility and to determine the proportion emissions attributable to the biochar project. Conversion factors for energy content are provided in the Biochar CRT Calculation Tool, to which facility output amounts are to be applied to determine the values for the variables in Equation 5.7.

Equation 5.7. Adjustment factor for proportional allocation of emissions in co-production settings

$$\boldsymbol{AF} = {(\boldsymbol{M_B} \times \boldsymbol{EE_B})}/{\boldsymbol{E_{ProdTot}}}$$

Where,

			Units
AF	=	Proportional adjustment to emissions to account for only project-related emissions	%
M_B	=	Total mass of biochar produced under the project for the reporting period	tonnes
EE_B	=	Energetic equivalent of all biochar generated under the project for CRT quantification purposes for the reporting period	MWh/tonne/yr
$E_{ProdTot}$	=	Total energetic equivalent output of all co-products generated by the facility producing biochar for the project during the reporting period	MWh/yr

And

$$\boldsymbol{E_{ProdTot}} = (\boldsymbol{M_B} \times \boldsymbol{EE_B}) + (\boldsymbol{EP_{Tot}} \div \boldsymbol{PD_{EP}} \times \mathbf{365}) + (\boldsymbol{TE_{Th}} \times \boldsymbol{EE_{Th}}) + (\boldsymbol{M_O} \times \boldsymbol{EE_O})$$

Where,

EP_{Tot}	=	Total amount of electricity generated by the facility producing biochar for the project during the reporting period	MWh
PD_{EP}	=	Total number of days electricity was produced by the biochar production facility for the reporting period	days
TE_{Th}	=	Total usable thermal energy generated by the biochar production facility for the reporting period and not used in electricity generation (e.g., steam for heating, food, and/or fiber processing)	lbs/hr of steam
EE_{Th}	=	Energetic equivalent of all usable thermal energy generated by the biochar production facility for the reporting period and not used in electricity generation (e.g., steam for heating, food, and/or fiber processing)	MWh/lbs/hr/yr
M_O	=	Total amount of all other products other than heat or electricity produced by the biochar production facility for the reporting period, including but not limited to non-project biochar, hydrogen, gas, and bio-oil.	variable units

[14] Based on factors from the Emissions & Generation Resource Integrated Database (eGRID) (US) or *Canada's National Inventory Report 1990-2020: Greenhouse Gas Sources and Sinks in Canada* for grid-connected electricity and from the US EPA GHG Emissions Hub for non-grid-connected electricity

EE_O	=	Energetic equivalent of all other products other than heat or electricity generated by the biochar production facility for the reporting period, including but not limited to non-project biochar, hydrogen, gas, and bio-oil.	MWh/unit/yr

5.2.1.5 Thermochemical Conversion Emissions

Emissions of CO_2 during the thermochemical conversion process are excluded from project accounting since such emissions are biogenic and considered carbon neutral relative to baseline emissions, as long as projects satisfy all relevant eligibility standards under this protocol, including feedstock eligibility requirements. Each project must account for methane emissions produced during thermochemical conversion using Equation 5.8 unless the project developer is able to demonstrate that emissions controls are in place so that emitted methane is combusted or recovered. Standardized emissions factors are provided in the Biochar CRT Calculation Tool based on the production process or emissions control technology used by the project. For biochar production processes or emissions control technologies for which an emissions factor is not provided in the tool, a default emissions factor based on methane emission rates from the uncontrolled combustion of biomass[15] must be used. Project developers may propose the addition of new emissions factors for production processes and emissions control technologies not covered by the tool based on supporting evidence such as peer-reviewed studies or publications from governmental agencies. The Reserve will update emissions factors provided in the Biochar CRT Calculation Tool at its sole discretion.

Equation 5.8. Thermochemical conversion methane emissions

$$\boldsymbol{PE_{PY} = \sum_{TC,F} EF_{TC} \times M_{F,TC} \times GWP_{CH4} \times AF}$$

Where,			Units
PE_{PY}	=	Total methane emissions from pyrolysis of feedstocks for the reporting period	tCO_2e
EF_{TC}	=	Emissions factor for production process *TC* used to produce biochar	tCH_4/t biomass
$M_{F,TC}$	=	Mass of feedstock type *F* produced during the reporting period using production process *TC*	t biomass
GWP_{CH4}	=	Global warming potential of CH_4	tCO_2e/tCH_4
AF	=	Proportional adjustment to emissions to account for only project-related emissions (see Equation 5.7)	%

5.2.1.6 Biochar Processing Emissions

For projects involving the processing of biochar in preparation for its end use, project developers must account for the emissions associated with such activities using Equation 5.9. Biochar processing may involve grinding, sifting, blending, and other similar actions. For projects under which biochar processing takes place after delivery to an end user, emissions are determined using default emissions factors applicable on a per tonne of delivered biochar basis, assuming certain processing practices to prepare biochar for the anticipated end use.

Equation 5.9. Biochar processing emissions

$$\boldsymbol{PE_{BP} = \left(PE_{BP,FC} + PE_{BP,EC}\right)}$$

Where, Units

[15] Based on open burning of forest slash piles

PE_{BP}	=	Total emissions from energy used to process biochar prior to end use application for the reporting period	tCO_2e

And, for calculation of emissions from fossil fuel combustion:

Either based on fuel records,

$$\boldsymbol{PE_{BP,FC} = \sum_{ff} FC_{BP,ff} \times EF_{BP,ff}}$$

Where,

$PE_{BP,FC}$	=	Emissions associated with the combustion of fuels to process biochar	tCO_2e
$FC_{BP,ff}$	=	Total mass or volume of fuel type *ff* consumed for biochar processing purposes for the reporting period	mass or volume unit
EF_{ff}	=	Emissions factor for the fuel type *ff*	tCO_2e/(mass or volume unit)

Or based on processing type and mass of feedstocks processed,

$$\boldsymbol{PE_{BP,FC} = \sum_{p} M_{bp} \times EF_{bp}}$$

Where,

M_p	=	Total mass of biochar processed using processing type *bp*	tonnes
EF_p	=	Emissions factor for processing type *bp*	tCO_2e/tonne

And for calculation of emissions from electricity consumption:

Either based on electricity consumption records,

$$\boldsymbol{PE_{BP,EC} = EC_{BP} \times EF_{EC}}$$

Where,

$PE_{BP,FC}$	=	Emissions associated with the use of electricity to process biochar	tCO_2e
EC_{BP}	=	Total amount of electricity consumed for biochar processing purposes for the reporting period	kwh
EF_{EC}	=	Emissions factor for electricity at the feedstock processing location[16]	tCO_2e/kwh

Or based on processing type and mass of feedstocks processed,

$$\boldsymbol{PE_{BP,FC} = \sum_{p} M_{bp} \times EF_{bp}}$$

Where,

M_{bp}	=	Total mass of biochar processed using processing type *bp*	tonnes
EF_{bp}	=	Emissions factor for processing type *bp*	tCO_2e/tonne

5.2.1.7 Biochar Transportation Emissions

Emissions from biochar transportation are required to be accounted for when biochar is being applied for certain end uses that are not a replacement or alternative to other materials. The Eligible Biochar End Uses list indicates whether transportation emissions must be determined for each end use listed. The results from Equation 5.10 are entered into Equation 5.1 as PE_{BT}.

[16] Based on factors from the Emissions & Generation Resource Integrated Database (eGRID) (US) or *Canada's National Inventory Report 1990-2020: Greenhouse Gas Sources and Sinks in Canada* for grid-connected electricity and from the US EPA GHG Emissions Hub for non-grid-connected electricity

Equation 5.10. Biochar transportation emissions

Equation 5.10a: Calculation of feedstock transportation emissions based on fuel records

$$PE_{BT} = \sum_{ff} V_{ff} \times EF_{ff}$$

Where,

			Units
PE_{BT}	=	Total emissions from transportation of biochar for the reporting period	tCO_2e
V_{ff}	=	Volume of fuel type *ff* consumed	unit of volume
EF_{ff}	=	Emissions factor for fuel type *ff*	tCO_2e/unit of volume

Equation 5.10b: Calculation of feedstock transportation emissions based on transportation type, mass of feedstock transported, and distance traveled

$$PE_{BT} = \sum_{tr} M_{b,tr} \times D_{b,tr} \times EF_{tr}$$

Where,

M_{tr}	=	Mass of biochar transported by transportation type *tr*	tonnes
D_{tr}	=	Total distance biochar was transported using transportation type *tr* for the reporting period	km
EF_{tr}	=	Emissions factor for transportation type *tr*	tCO_2e/tonne-km

5.2.2 Calculating Project Removals

The long-term storage of carbon in biochar is the primary GHG benefit expected to be generated by projects under this protocol. Calculations of total project removals (Equation 5.11) rely on metrics derived from the type of biochar (*b*) and end use (*EU*). The type of biochar is based on a combination of the feedstock mix and production conditions that are represented by the results from biochar sampling and laboratory testing described in Section 6.2. The final end use(s) of biochar produced by the project determines the expected longevity of the sequestered carbon. For each end use, the applicable permanence factor (P_{EU}) is indicated in the Eligible Biochar End Uses List and incorporated in the Biochar CRT Calculation Tool.

For soil applications and other similar end uses, the permanence factor applicable to a given amount of biochar is based on the equation described by Woolf *et al.* (2021). See the Eligible Biochar End Uses List for further details. The equation is dependent on both the ratio of hydrogen to organic carbon ($H:C_{org}$), as indicated by laboratory analysis of biochar samples from the project, and the average soil temperature of the location(s) where biochar is applied, as reported via chain-of-custody tracking. As described under Section 3.5, the long-term durability of biochar is derived from the highly stable molecular structure resulting from the thermochemical conversion process that results in a lowered $H:C_{org}$ ratio relative to the biomass source. Yet degradation of a portion of biochar does occur over shorter time scales in soils (and similar settings), with the rate of degradation increasing with soil temperature. Thus, for projects involving soil or similar applications, the end uses *EU* must also be differentiated by soil temperature groups as well. The Reserve provides a standardized spatial layer of mean annual soil temperature[17] to be used by project developers to determine the soil temperature of end

[17] Available at https://www.climateactionreserve.org/how/protocols/ncs/biochar/

use locations associated with the biochar from the project. For situations where biochar is provided to an entity operating as a "mixer", as discussed in Section 2.2.3, where the final location of soil application is unclear, the range of potential locations where the biochar may be applied must be identified and the most conservative soil temperature applied for CRT quantification.

Equation 5.11. Carbon removals

$$\boldsymbol{PC = \sum_{b} PC_b}$$

Where,

			Units
PC	=	Total C removals for the reporting period	tCO_2e
PC_b	=	C removals for biochar type *b*	tCO_2e

And

$$\boldsymbol{PC_b = \sum_{b,EU} M_{b,EU} \times DM_b \times OC_b \times P_{EU} \times 3.67}$$

Where,

$M_{b,EU}$	=	Mass (wet basis) of biochar type *b* for end use type *EU* for the reporting period	tonnes
DM_b	=	Dry matter composition of biochar type *b* for the reporting period, based on ratio of post- to pre-drying mass of biochar sample (see Section 6.2.1)	%
OC_b	=	Organic carbon content of biochar type *b* for the reporting period, based on the lower bound of the 95% confidence interval of the mean value determined from sampling and laboratory analysis (see Section 6.4)	%C
P_{EU}	=	Permanence factor for end use *EU*	%
3.67	=	Factor to convert from tC to tCO_2e	

For those permanence factors based in part on the $H:C_{org}$ ratio, the upper bound of the 95% confidence interval of the mean value for $H:C_{org}$ ratio determined from sampling and laboratory analysis (see Section 6.4) must be used. If laboratory results from maintenance sampling (see Table 6.1) indicate a higher $H:C_{org}$ value or a lower value for OC_b than is indicated by their initial sampling results, the biochar produced during the intervening time between such maintenance sampling and the completion of the most recent prior sampling effort (whether initial or maintenance sampling) must be excluded for CRT quantification purposes. Project emissions during that time would similarly be excluded. However, if laboratory analysis of at least 10 retention samples (see Table 6.1) taken during that same period of time indicate a mean value within the 95% confidence interval, the biochar from that period, and any associated project emissions, may be included in CRT quantification.

5.3 Leakage

The risk of leakage—a shifting of GHG emissions outside of the project boundaries as an indirect effect of the project—is generally limited or non-existent in most scenarios under which biochar projects will be developed for climate benefits, in particular when waste or by-product biomass is used as a feedstock since such biomass is typically not being diverted from an alternative productive use. Nevertheless, two situations have been identified that present a risk of leakage: 1) the use of purpose-grown feedstocks and 2) the diversion of biomass from bioenergy production, including within-facility diversions.

The eligibility requirements of Section 2.2,Eligible Biochar Feedstocks List, and Section 3.4.1 limit purpose-grown feedstocks to those for which a leakage risk is insignificant. In particular, since production of purpose-grown feedstocks is limited to marginal farmland or reclaimed mining sites, as previously described in Section 2.2.1, there is minimal risk that additional land would be converted—with associated GHG emissions and releases of sequestered carbon—to make up for any production from the land being used for biochar feedstock production. As such, no leakage calculation is required for projects using eligible purpose-grown feedstocks.

If biomass is diverted from bioenergy production, any resulting decrease in bioenergy output may be compensated for with fossil fuel-based energy. Such leakage would lower the climate benefits of a biochar project using the diverted biomass. If a project developer is acquiring feedstocks from a landscape where that biomass source is typically used for bioenergy and the project developer is unable to confirm that bioenergy production is not supply-limited, the project would not be eligible, per the Performance Standard Test outlined in Section 3.4.1.1. If bioenergy production is not supply-limited, however, no leakage would occur as a result of the diversion of feedstock since the bioenergy output would not be impacted by an eligible biochar project.

For projects involving the diversion of biochar from within a bioenergy production process (e.g., diversion of fly ash from reinjection into a bioenergy furnace), the project developer must demonstrate that bioenergy production levels are being maintained such that the energy output of the facility does not decrease by more than 5 percent annually based on average daily output. If energy production decreases by more than 5 percent when compared to the average daily output from the facility for three years immediately preceding the start date (or for as long as the facility has been in operation if less than three years), the project must calculate the emissions associated with leakage from the project based on replacement of the energy output decreases in excess of 5 percent based on electrical grid emissions rates from the location of the biochar facility. This calculation is performed using Equation 5.12. The resulting value for *LE* is inserted into Equation 5.1.

Equation 5.12. Leakage emissions

$$If\ \boldsymbol{EP_{Post} \geq EP_{Pre} \times 95\%}$$

$$then\ \boldsymbol{LE = 0}$$

$$If\ \boldsymbol{EP_{Post} < EP_{Pre} \times 95\%}$$

$$then\ \boldsymbol{LE = \left(\left|\frac{EP_{Post} - EP_{Pre}}{EP_{Pre}}\right| - 0.05\right) \times EP_{Pre} \times t_{RP} \times EF_{EC}}$$

Where,

LE	=	Leakage emissions associated with the replacement of energy output resulting from decreases from bioenergy facilities from which biomass feedstocks were diverted for biochar production	tCO_2e
EP_{Post}	=	Average daily amount of grid-connected electricity produced during the reporting period	kwh/day
EP_{Pre}	=	Average daily amount of grid-connected electricity produced during the three years immediately preceding the project start date	kwh/day
t_{RP}	=	Total number of days comprising the current reporting period	days

EF_{EC}	=	Emissions factor for grid-connected electricity at the feedstock processing location[18]	tCO_2e/kwh

5.4 Reconciliation with Stacked Projects

As previously described, biochar projects have the opportunity to be implemented in such a way that project activities overlap with the project activities attributable to another project type. If such project stacking is approved by the Reserve, guidance may be required to be provided by Reserve staff to reconcile the quantification of the biochar with the quantification of the stacked project(s) to ensure no double-counting/crediting of GHG impacts occurs. The Reserve maintains the right to determine if any reconciliation between a biochar project and another project with which it is stacked is necessary and what the requirements for such reconciliation may be.

[18] Based on factors from the Emissions & Generation Resource Integrated Database (eGRID) (US) or *Canada's National Inventory Report 1990-2020: Greenhouse Gas Sources and Sinks in Canada*

6 Project Monitoring

Monitoring is the process of regularly collecting data related to a project's performance for reporting purposes. Project developers are required to gather data pertaining to a biochar project on a regular basis and report such data for each reporting period, as further described in Section 7.3. Thus, project developers are responsible for monitoring the performance of the project and ensuring that the operation of all project-related equipment is consistent with the manufacturer's recommendations (as applicable) and that all project-related processes are compliant with all relevant legal and regulatory requirements. Monitoring is required for the duration of the crediting period.

6.1 Monitoring Plan

The Reserve requires a monitoring plan to be established for all monitoring and reporting activities associated with the project. The monitoring plan will serve as the basis for verifiers to confirm that the monitoring and reporting requirements in this section and Section 7 have been and will continue to be met, and that consistent, rigorous monitoring and record keeping is ongoing at the project site. The monitoring plan must cover all aspects of monitoring and reporting contained in this protocol and must specify how data for all relevant parameters in Table 6.1 will be collected and recorded.

At a minimum, the monitoring plan shall include the following details:

1. General description of the project, including:
    a. Feedstock characterization
    b. Biochar production process(es) employed, including configurations of production parameters, as defined by unique combinations of feedstock compositions and biochar production temperature and residence time (Section 6.4)
    c. End uses of biochar
2. A description of how the eligibility requirements are met
    a. The monitoring plan must include procedures that the project developer will follow to ascertain and demonstrate that the project at all times passes the legal requirement test (Section 3.4.2) and maintains regulatory compliance (Section 3.6)
    b. A description of any ecosystem services payments stacking and/or project stacking occurring or expected to occur
3. The frequency of instrument cleaning, inspection, field check, and calibration activities (if relevant), including for scales used to determine the mass of biochar produced and biochar samples collected for estimation of dry matter composition.
4. A description of each monitoring task to be undertaken, and the technical requirements therein
5. Roles, responsibilities, and capacity of monitoring team and management
6. Data to be collected per chain of custody tracking requirements (Section 6.1) and process for collecting and compiling such data
7. Parameters to be measured, including any parameters additional to those specified in Table 6.2.
8. Data to be collected and data collection techniques and sample designs for directly sampled parameters, per requirements outlined in Section 6.4.
9. Operational data to be documented, including production parameters.
10. Frequency of data acquisition. At a minimum, the data required for quantification of biochar projects shall be monitored and recorded (or documented, as appropriate) for each reporting period.

11. Data archiving procedures (see Section 7.3 for minimum record keeping requirements)
12. QA/QC provisions to ensure that data acquisition, compilation, and reporting are carried out consistently and with precision (where relevant).

The Reserve will make available a Monitoring Plan template that includes sections for all required information. Use of the template is not required but is strongly recommended.

6.2 Monitoring Report

A monitoring report must be prepared for each reporting period. Monitoring reports must be provided to verification bodies whenever a biochar project undergoes verification. All monitoring reports are due within 12 months of the end of the Reporting Period, including for any reporting period for which verification is being deferred (see Section 7.3 for further information about deferred verifications). Monitoring reports must include the following:

1. Records and results from data collection and monitoring indicated in the monitoring plan for the project, including but not limited to:
    a. Description of the project configuration (feedstocks, production parameters, end uses) for the reporting period, including any production-related problems or stoppages that may have an impact on credit quantification and materials standards requirements under this protocol.
    b. Indication of how Performance Standard Test and Legal Requirements Test were met
    c. Description of compliance with relevant laws and regulations, as well as environmental and social safeguards
    d. Information pertaining to sampling of biochar performed during the reporting period
    e. Description of and results from laboratory analyses, if performed for the reporting period
    f. Data and supporting documentation for monitoring parameters identified in Table 6.2
2. Chain of custody documentation to corroborate reported data
3. Description of any ecosystem services payments and/or project stacking, if occurring, with prior approval and guidance from the Reserve
4. A copy of Biochar CRT Calculation Tool with credit quantification results

A monitoring report template is provided on the webpage for the biochar protocol[19] for optional use by project developers.

6.3 Chain of Custody Tracking

The project developer must collect and maintain documentation on the chain of custody of the biochar, from the biomass acquisition, through biochar production, and biochar application. At all stages, this should include the names, addresses, and contact information of the parties in the chain of custody at a minimum. Chain of custody requirements for each phase are identified in Table 6.1 below. Chain of custody should be tracked by paper bills of lading, or electronic, third-party tracking. Only the amounts of biochar that are properly documented in the chain of custody may be included for credit quantification.

[19] https://www.climateactionreserve.org/how/protocols/ncs/biochar/

Table 6.1. Chain of Custody Requirements

Phase	Chain of Custody Requirements
Biomass Acquisition	▪ Name of each party ▪ Address of each party ▪ Contact information of each party, including phone number and email address ▪ Identification of feedstock, which must be on the Eligible Biochar Feedstocks List ▪ Physical location (parcel, facility, etc.) of the feedstock source ▪ Date the feedstock was obtained/harvested ▪ Mass of feedstock obtained/harvested
Biochar Production	▪ Name of each party ▪ Address of each party ▪ Contact information of each party, including phone number and email address ▪ Date the biomass was acquired ▪ Mass of biomass acquired ▪ Date the biochar was produced ▪ Mass of biochar produced ▪ Date it was transported from the production facility
Biochar Application	▪ Name of each party ▪ Address of each party ▪ Contact information of each party, including phone number and email address ▪ Mass of biochar received by each party ▪ End-use application, which must be included on the Eligible Biochar End Uses List* ▪ Location of end-use application**

*For projects distributing biochar to an intermediary entity that will subsequently distribute the biochar (as described in Section 2.2.3), chain of custody tracking is only required to the transfer of the intermediary entity, with the assumed end-use application similarly documented.
**If end-use application is an intermediary entity as described above and the applicable permanence factor depends on a determination of soil temperature, the range of locations for ultimate end use (based on the potential distribution from the intermediary entity) must be identified. If the range of potential ultimate end use locations is unable to be identified and substantiated, the most conservative values for the relevant permanence factor must be used.

6.4 Biochar Sampling and Testing Guidance

Ongoing sampling and testing of biochar being produced is critical to properly assessing the eligibility of a project and quantifying the climate benefits it provides..

Direct measurement of various characteristics of biochar must be performed via sampling to establish eligibility and certain credit quantification parameters. Measurements related to eligibility include the $H:C_{org}$ ratio and levels of constituent chemicals specified as environmental safeguards, per Sections 3.5 and 3.7. Quantification parameters derived from biochar sampling include percent dry matter (DM_b) and percent organic carbon (OC_b) and may also include the $H:C_{org}$ ratio for certain end uses.

Estimates derived from sampling are subject to statistical uncertainty. Where statistical confidence is low, there is an increased risk of overestimating the durable carbon contained in the biochar produced under a project and therefore a higher risk of over-crediting carbon

removals. To help ensure that estimates of removals are conservative, projects must meet minimum statistical accuracy standards and apply parameter estimates as described in Section 6.4.1.

Project owners must provide documentation describing the biochar sampling and laboratory analysis methods employed. While this protocol does not require specific sampling and laboratory analysis methods to be used, it does require that a set of minimum standards be met, as outlined in the following sections.

Initial Parameter Sampling and laboratory analysis must be performed at the start of the project to establish credit quantification parameters and project eligibility in relation to the properties of project biochar (see Table 6.2), while ongoing Retention Sampling is required throughout the crediting period to update quantification parameters and demonstrate ongoing eligibility. Changes in certain production parameters over time can result in significant modifications to biochar properties used for credit quantification, causing samples taken prior to such production parameter changes to not accurately represent biochar produced after those changes. Of particular importance for the metrics used for credit quantification under this protocol are the types of feedstocks used, the temperature of the thermochemical conversion process, and the length of time biomass is subject to the thermochemical conversion process (residence time). If production parameters change in one or more of the following ways, Initial Parameter Sampling must be performed again to establish new quantification parameters and demonstrate eligibility of the biochar generated under those production parameters:

- The composition of feedstocks used to produce biochar (based on eligible sources identified in the Eligible Biochar Feedstocks List) changes by 10% or more;
- The thermochemical conversion temperature changes by +/-50 degrees C or more during production for more than 2 hours, including for planned and unplanned interruptions; or
- The residence time changes by +/-10% or more for more than 2 hours.

6.4.1 Sample Design and Collection

Although the approach to sampling biochar will be similar from project to project, Project Developers must describe their sampling approach in the Monitoring Plan. Regardless of the exact approach used, all projects must adhere to the minimum standards identified in Table 6.2.

Table 6.2. Minimum Standards for Sampling Biochar

Category	Guidance
Initial Parameter Sampling	To establish the values for the $H:C_{org}$ ratio and for the variables DM_b and OC_b in Equation 5.10 at the start of biochar production under a given set of production parameters and to test for other physicochemical properties related to eligibility, initial parameter sampling must be performed based on the following guidance.

<table>
<tr><th>Category</th><th>Guidance</th></tr>
<tr><td>Sampling approach</td><td>

Facility samples are submitted for laboratory analysis (see Section 6.4.2).
Daily samples are the basis for assessing threshold and accuracy metrics for H:C_{org} and DM_b and OC_b:

<table>
<tr><td></td><td></td><td></td></tr>
<tr><td>H:C_{org}</td><td>Upper bound of 95% confidence interval of the sample mean</td><td><0.7 for eligibility of biochar

Calculation of permanence factor (P_{EU}) for certain end uses</td></tr>
<tr><td>DM_b</td><td>Lower bound of 95% confidence interval of the sample mean</td><td>Calculation of total carbon removals from the project (PC)</td></tr>
<tr><td>OC_b</td><td>Lower bound of 95% confidence interval of the sample mean</td><td>Calculation of total carbon removals from the project (PC)</td></tr>
<tr><td>Contaminants (e.g., heavy metals, PAHs, PCBs)</td><td>Average of samples</td><td>Must be below maximum legal allowance threshold, per contaminant, for biochar to be eligible</td></tr>
</table>

No minimum number of samples is required. Rather, the sample size will be determined by the ability of sampling and subsequent laboratory analysis results to mee the statistical confidence threshold.

</td></tr>
<tr><td>Sample collection process</td><td>

Sampling details (dates, times, personnel involved, biochar production configuration) must be documented for all sampling performed for the project.
A minimum of 6 subsamples must be drawn each day biochar is produced and combined to produce a single composite sample representative of that day’s production.
The daily biochar must be thoroughly mixed prior to sampling.
Subsamples must be extracted from different locations of the biochar volume being sampled.
Collected subsamples are combined into a single composite sample for storage and shipment for laboratory analysis.
Samples must be placed in containers made of material appropriate for the type of laboratory analyses being performed, as described in the IBI Standardized Product Definition and Product Testing Guidelines for Biochar that Is Used in Soil.
Projects employing multiple production units may sample from a single unit as long as the production parameters are sufficiently similar, as previously described in Section 6.4, so as not to require a separate sampling effort.

</td></tr>
</table>

Category	Guidance

Timing of sampling	▪ Sampling must be performed from the first day of biochar production under the project and during the reporting period for which the associated laboratory analysis results are applicable.
	▪ Sampling must be performed before post-processing when biochar is processed in the following ways:
	  o Biological activation
	  o Mixing/blending/adding non-biochar material
	▪ Sampling may be performed after post-processing when biochar is processed in all other ways.

Sample handling	▪ Samples must be securely packaged and clearly labeled ▪ Samples must be shipped within 5 days of collection and should be kept cool until shipping.
Retention sampling	Composite samples must be extracted regularly and retained for archival purposes and for parameter updating as described here. ▪ After Initial Parameter Sampling is completed, a ½-liter composite sample must be extracted from the biochar produced each day. ▪ At the end of each month, the Project Developer must contact the Reserve and indicate the number of days of production in the month just completed. Reserve staff will randomly select a production day from which the retention sample must be sent to a laboratory for analysis of $H:C_{org}$ and organic carbon content. ▪ Laboratory results for $H:C_{org}$, dry matter, and organic carbon content from testing of a new retention sample will replace the earliest composite sample from Initial Parameter Sampling. In this way, values for $H:C_{org}$ and organic carbon content will be updated over time, though the total sample size serving as the basis for such values will remain constant. ▪ Additionally, at any time during the crediting period for a project, the Reserve may require retained samples to be analyzed to ensure samples analyzed for reporting purposes are representative of biochar reported to be produced under the same production parameters. The selection of a project and/or reporting period for retention sample testing shall be made at the sole discretion of the Reserve. Such testing will be conducted at the Reserve's expense.

The Reserve may, at the time of its own choosing, coordinate with the project developer to conduct its own sampling of biochar being produced under a project as a check on the sampling and laboratory analyses being reported for the project.

[**NOTE TO WORKGROUP:** We are considering using the same basic approach to sampling, including as it relates to establishing and updating confidence intervals for $H:C_{org}$, dry matter content, and organic matter content, but instead requiring the use of a NELAC-/NEFAP-accredited Field Sampling and Measurement Organization to perform sampling. The intent would be to reduce the risk of improper sampling, whether intentional or unintentional, to maintain credibility since verification will have a limited window into operations that are potentially variable on a day-to-day basis.

Considering these concerns, we would appreciate your feedback on the use of this potential approach, especially in terms of feasibility, practicality, and cost.]

6.4.2 Laboratory Analysis

Project developers must describe in the Monitoring Plan the types of laboratory analyses to be performed on the biochar samples from the project and the methods used for each. All projects must have biochar samples analyzed to determine both the organic carbon content (OC_b) and the $H:C_{org}$ ratio. Additional laboratory analyses to be performed are based on the regulatory requirements associated with the end use for the biochar, as described in Section 3.6 and any additional environmental safeguards described Section 3.7 in the Eligible Biochar Feedstocks List or the Eligible Biochar End Uses List. Specific analytical methods employed must be in line with the methods specified by either the *IBI Standardized Product Definition and Product Testing Guidelines for Biochar that Is Used in Soil* or the *European Biochar Certificate – Guidelines for a Sustainable Production of Biochar*. Additional analytical standards may be approved by the Reserve. A complete list of approved analytical standards will be maintained on the Biochar Protocol webpage.[20]

Sample homogenization and testing must be performed by a laboratory that is accredited under a relevant national governing body or international standard-setting body, such as the National Environmental Laboratory Accreditation Program (NELAP), American Association for Laboratory Accreditation (A2LA), or International Standards Organization (ISO). The laboratory must be specifically accredited under ISO/IEC 17025 "General Requirements for the Competence of Testing and Calibration Laboratories." Additionally, project developers must obtain quality assurance/quality control information from the laboratory analyzing the project samples, which shall be reviewed during verification for reasonableness.

6.5 Monitoring Permanence

In most cases, the initial application of biochar signifies the end use considered for permanence purposes, for which there are reasonably high assurances that the biochar will not be altered or impacted in a way that releases the carbon it contains prior to the end of the time it is assumed to remain sequestered, as described in this protocol. However, there may be initial applications of biochar for which permanence is not ensured until the biochar is applied to an ultimate end use. For example, biochar initially used for agricultural filtration purposes may end up being combusted or it may be applied to soils as an amendment. To be eligible for crediting purposes under this protocol, biochar must be applied to an end use for which the permanence of the carbon sequestered in project biochar is reasonably assured, as described in Section 3.5, including those situations where the length of time the carbon can reasonably be expected to remain sequestered is less than 100 years. As such, only biochar used in those applications listed in the Eligible Biochar End Uses List may be included for project reporting and credit quantification purposes.

[20] https://www.climateactionreserve.org/how/protocols/ncs/biochar/

6.6 Monitoring Parameters

Prescribed monitoring parameters necessary to calculate baseline and project emissions are provided in Table 6.2.

Table 6.3. Biochar Project Monitoring Parameters

Eq. #	Parameter	Description	Data Unit	Calculated (c) Measured (m) Reference (r) Operating Records (o)	Measurement Frequency	Comment
Baseline Calculation Parameters						
Eq. 5.1	*BE*	Total baseline emissions for the reporting period, from all emission-based SSRs in the GHG Assessment Boundary.	tCO_2e	r	Each reporting period	Assumed to be zero
Eq. 5.1	*BC*	Total carbon sequestered in the baseline scenario for the reporting period	tCO_2e	r	Each reporting period	Assumed to be zero
Project Calculation Parameters						
Eq. 5.3	A_F	Area harvested for feedstock *F*	acres	m	Each reporting period	
Eq. 5.3	EF_F	Emissions factor for production of purpose-grown biomass feedstock type *F*	tCO_2e/acre	r	Each reporting period	Provided in Biochar CRT Calculation Tool
Eq. 5.4a, Eq. 5.10a	V_{ff}	Volume of fuel type *ff* consumed	CO_2e	o	Each reporting period	
Eq. 5.4a, Eq. 5.5, Eq. 5.6, Eq. 5.10a	EF_{ff}	Emissions factor for fuel type *ff*	tCO_2e/unit of volume	r	Each reporting period	Provided in Biochar CRT Calculation Tool
Eq. 5.4b, Eq. 5.10b	M_{tr}	Mass of biomass or biochar transported by transportation type *tr*	tonnes	m	Each reporting period	
Eq. 5.4b, Eq. 5.10b	D_{tr}	Distance biomass or biochar transported by transportation type *tr*	km	o	Each reporting period	
Eq. 5.4b, Eq. 5.10b	EF_{tr}	Emissions factor for transportation by transportation type *tr*	tCO2e/tonne-km	r	Each reporting period	Provided in Biochar CRT Calculation Tool
Eq. 5.5	$FC_{Fproc,ff,F}$	Total mass or volume of fuel type *ff* consumed for the processing of feedstock type *F* for the reporting period	mass or volume unit	o	Each reporting period	
Eq. 5.5	M_{fp}	Total mass of feedstocks processed using processing type *fp*	tonnes	m	Each reporting period	
Eq. 5.5	$EF_{FC,fp}$	Emissions factor for fossil fuel consumption using processing type *fp*	tCO_2e/tonne	r	Each reporting period	Provided in Biochar CRT Calculation Tool

Eq. #	Parameter	Description	Data Unit	Calculated (c) Measured (m) Reference (r) Operating Records (o)	Measurement Frequency	Comment
Eq. 5.5	$EC_{FProc,F}$	Total amount of electricity consumed for the processing of feedstock type *F* for the reporting period	kWh	o	Each reporting period	
Eq. 5.5, Eq. 5.6, Eq. 5.9	EF_{EC}	Emissions factor for electricity at the feedstock processing location	tCO_2e/kWh	r	Each reporting period	Provided in Biochar CRT Calculation Tool
Eq. 5.5	$EF_{EC,fp}$	Emissions factor for electricity consumption using processing type *fp*	tCO_2e/tonne	r	Each reporting period	Provided in Biochar CRT Calculation Tool
Eq. 5.6	$FC_{AE,ff}$	Total mass or volume of fuel type *ff* consumed for biochar production purposes for the reporting period	mass or volume unit	o	Each reporting period	
Eq. 5.6	EC_{AE}	Total amount of electricity consumed for biochar production purposes for the reporting period	kWh	o	Each reporting period	
Eq. 5.7	M_B	Total mass of biochar produced under the project for the reporting period	tonnes	m	Each reporting period	
Eq. 5.7	E_B	Energetic equivalent of all biochar generated under the project for CRT quantification purposes for the reporting period	MWh/tonne/yr	r	Each reporting period	Provided in Biochar CRT Calculation Tool
Eq. 5.7	EP_{Tot}	Total amount of electricity generated by the facility producing biochar for the project during the reporting period	MWh	o	Each reporting period	
Eq. 5.7	PD_{EP}	Total number of days electricity was produced by the biochar production facility for the reporting period	days	o	Each reporting period	
Eq. 5.7	TE_{Th}	Total usable thermal energy generated by the biochar production facility for the reporting period and not used in electricity generation (e.g., steam for heating, food, and/or fiber processing)	lbs/hr of steam	o	Each reporting period	
Eq. 5.7	EE_{Th}	Energetic equivalent of all usable thermal energy generated by the biochar production facility for the reporting period and not used in electricity generation (e.g., steam for heating, food, and/or fiber processing)	MWh/lbs/hr/yr	r	Each reporting period	Provided in Biochar CRT Calculation Tool
Eq. 5.7	M_O	Total amount of all other products other than heat or electricity produced by the biochar production facility for the reporting period, including but not limited to non-project biochar, hydrogen, gas, and bio-oil.	variable units	o	Each reporting period	

Eq. #	Parameter	Description	Data Unit	Calculated (c) Measured (m) Reference (r) Operating Records (o)	Measurement Frequency	Comment
Eq. 5.7	EE_O	Energetic equivalent of all other products other than heat or electricity generated by the biochar production facility for the reporting period, including but not limited to non-project biochar, hydrogen, gas, and bio-oil.	MWh/unit/yr	r	Each reporting period	Provided in Biochar CRT Calculation Tool
Eq. 5.8	EF_{TC}	Emissions factor for production process *TC* used to produce biochar	tCH_4/t biomass	r	Each reporting period	Provided in Biochar CRT Calculation Tool
Eq. 5.8	$M_{F,TC}$	Mass of feedstock type *F* produced during the reporting period using production process *TC*	t biomass	m	Each reporting period	
Eq. 5.8	GWP_{CH4}	Global warming potential of CH_4	tCO_2e/tCH_4	r	Each reporting period	Provided in Biochar CRT Calculation Tool
Eq. 5.9	$FC_{BP,ff}$	Total mass or volume of fuel type *ff* consumed for the processing of biochar for the reporting period	mass or volume unit	o	Each reporting period	
Eq. 5.9	M_{bp}	Total mass of biochar processed using processing type *bp*	tonnes	m	Each reporting period	
Eq. 5.9	$EF_{FC,bp}$	Emissions factor for fossil fuel consumption using processing type *bp*	tCO_2e/tonne	r	Each reporting period	Provided in Biochar CRT Calculation Tool
Eq. 5.9	EC_{BP}	Total amount of electricity consumed for the processing of biochar for the reporting period	kWh	o	Each reporting period	
Eq. 5.9	$EF_{EC,bp}$	Emissions factor for electricity consumption using processing type *bp*	tCO_2e/tonne	r	Each reporting period	Provided in Biochar CRT Calculation Tool
Eq. 5.11	$M_{b,EU}$	Mass (wet basis) of biochar type *b* for end use type *EU* for the reporting period	tonnes	m	Each reporting period	
Eq. 5.11	DM_b	Dry matter composition of biochar type *b* for the reporting period, based on the lower bound of the 95% confidence interval of the mean value	%	m	Each reporting period	Based on sampling and laboratory analysis (see Section 6.4)
Eq. 5.11	OC_b	Organic carbon content of biochar type *b* for the reporting period, based on the lower bound of the 95% confidence interval of the mean value	%C	m	Each reporting period	Based on sampling and laboratory analysis (see Section 6.4)
Eq. 5.11	P_{EU}	Permanence factor for end use *EU*	%	c, r	Each reporting period	
Eq. for P_{EU} for soil applications	c_{hc}	Co-efficient for calculation of soil application-related permanence factor, dependent on soil temperature	n/a	r	Each reporting period	Equation provided in Biochar Eligible End Uses List
Eq. for P_{EU} for soil applications	m_{hc}	Co-efficient for calculation of soil application-related permanence factor, dependent on soil temperature	n/a	r	Each reporting period	Equation provided in Biochar Eligible End Uses List

Eq. #	Parameter	Description	Data Unit	Calculated (c) Measured (m) Reference (r) Operating Records (o)	Measurement Frequency	Comment
Eq. for P_{EU} for soil applications	H/C_{org}	$H:C_{org}$ ratio reported from sampling and laboratory analysis	%	m	Each reporting period	Equation provided in Biochar Eligible End Uses List. $H:C_{org}$ value applied must be the upper bound of the 95% confidence interval determined from biochar sampling.
Eq. 5.12	EP_{Post}	Average daily amount of grid-connected electricity produced during the reporting period	kwh/day	o	Each reporting period	
Eq. 5.12	EP_{Pre}	Average daily amount of grid-connected electricity produced during the three years immediately preceding the project start date	kwh/day	o	Each reporting period	
Eq. 5.12	t_{RP}	Total number of days comprising the current reporting period	days	o	Each reporting period	

7 Reporting Parameters

This section provides requirements and guidance on reporting rules and procedures. A priority of the Reserve is to facilitate consistent and transparent information disclosure among project developers. Project developers must submit verified emission reduction reports to the Reserve for every reporting period.

7.1 Project Submittal Documentation

Project developers must provide the following documentation to the Reserve to submit a biochar project for listing:

- Project Submittal form

Project developers must provide the following documentation to the Reserve each time a biochar project is verified to have CRTs issued:

- Monitoring Plan
- Monitoring Report, including chain of custody tracking documentation
- Signed Attestation of Title form
- Signed Attestation of Voluntary Implementation form
- Signed Attestation of Regulatory Compliance form
- Verification Report
- Verification Statement

At a minimum, the above project documentation will be available to the public via the Reserve's online registry. Further disclosure and other documentation may be made available on a voluntary basis through the Reserve. Project submittal forms can be found at http://www.climateactionreserve.org/how/program/documents/.

7.2 Record Keeping

For purposes of independent verification and historical documentation, project developers are required to keep all information outlined in this protocol for a period of 10 years after the information is generated or 7 years after the last verification. This information will not be publicly available, except as indicated in Section 7.1, but may be requested by the verifier or the Reserve.

System information the project developer should retain includes:

1. All data inputs for the calculation of the project emission reductions, including all required sampled data
2. Chain of custody documentation, including distances traveled
3. System characterization, including feedstocks composition, production parameters (e.g., production temperature and residence time), and operational records such as problems and production stoppages.
4. Copies of all permits, Notices of Violations (NOVs), and any relevant administrative or legal consent orders dating back at least 3 years prior to the project start date
5. Executed Attestation of Title, Attestation of Regulatory Compliance, and Attestation of Voluntary Implementation forms
6. Onsite fossil fuel use records

7. Onsite grid electricity use records
8. Results of CO_2e carbon removal calculations for each reporting period
9. Initial and annual verification records and results
10. All maintenance records relevant to the monitoring equipment

7.3 Reporting Period and Verification Cycle

A reporting period is a discrete period of time for which a project developer quantifies and reports GHG reductions and removals, as well as required project data to the Reserve. The maximum length of a reporting period under this protocol is 12 months, with the exception of projects with start dates preceding the adoption of this protocol, as described in Section 3.2, for which the initial reporting period may extend to 12 months after the date of protocol adoption. Project developers may choose to have a sub-annual reporting period and verification schedule (e.g., monthly, quarterly, or semi-annually). In all instances, reporting periods must be contiguous, i.e., there must be no gaps in reporting during the crediting period of a biochar project once the project has been registered. Even if there are gaps in project activities being reported, such gaps must be included in reporting periods and verified accordingly.

Required verification documentation (see Section 7.1) must be submitted within 12 months of the end of each reporting period, regardless of the length of a reporting period. Credits will only be issued after verification is successfully completed and the Reserve completes its review of the verification documentation. However, to provide flexibility, project developers may also opt to delay verification on the condition that they acknowledge no CRTs will be issued for any period of time that falls outside the standard window for completing verification of project data and documentation. Such zero-credit reporting periods are further described in the Reserve Offset Program Manual.[21]

All biochar projects must conduct at least two site visits during the ten year crediting period. A site visit verification is required for the verification of the initial reporting period and for the reporting period no more than 5 years since the starting date of the reporting period previously subject to a site visit verification, as long as the following requirements are met:

1. The verification is being conducted by the same verification body that conducted the site visit for the previous verification; and
2. There have been no significant changes in the project's production parameters used to produce biochar, as described in Section 6.4.

For example, if a project has a start date of January 1, 2024, with the crediting period ending December 31, 2033, a second site visit would be required, at a minimum, for the verification of the reporting period including January 1, 2029. However, a site visit verification is required for any reporting period during which the production parameters changes. For example, if the same project changed production parameters during a reporting period that started on June 4, 2027, a site visit would be required for that reporting period and a site visit would be required no later than for the verification of the reporting period including June 4, 2032.

For reporting periods shorter than 12 months, an optional desk review verification may be performed, as long as the minimum site visit verification schedule is maintained.

[21] Found on the Reserve website at https://www.climateactionreserve.org/how/program-resources/program-manual/.

8 Verification Guidance

This section provides verification bodies with guidance on verifying GHG emission reductions associated with the project activity. This verification guidance supplements the Reserve's Verification Program Manual and describes verification activities specifically related to biochar projects.

Verification bodies trained to verify biochar projects must be familiar with the following documents:

- Reserve Offset Program Manual
- Verification Program Manual
- Biochar Protocol
- Eligible Biochar Feedstocks List
- Eligible Biochar End Uses List
- Any applicable policy memos and errata and clarifications

The Reserve Offset Program Manual, Verification Program Manual, and protocols are designed to be compatible with each other and are available on the Reserve's website at http://www.climateactionreserve.org.

Only ISO-accredited verification bodies trained by the Reserve are eligible to verify biochar project reports. Information about verification body accreditation and Reserve project verification training can be found on the Reserve website at http://www.climateactionreserve.org/how/verification/.

8.1 Standard of Verification

The Reserve's standard of verification for biochar projects is the Biochar Protocol (this document), the Reserve Offset Program Manual, and the Verification Program Manual. To verify a biochar project report, verification bodies apply the guidance in the Verification Program Manual and this section of the protocol to the standards described in Sections 2 through 7 of this protocol. Sections 2 through 7 provide eligibility rules, methods to calculate emission reductions, performance monitoring instructions and requirements, and procedures for reporting project information to the Reserve.

8.2 Monitoring Plan

The Monitoring Plan serves as the basis for verification bodies to confirm that the monitoring and reporting requirements in Section 6 and Section 7 have been met, and that consistent, rigorous monitoring and record keeping is ongoing at the project site. Verification bodies shall confirm that the Monitoring Plan covers all aspects of monitoring and reporting contained in this protocol and specifies how data for all relevant parameters in Table 6.1 are collected and recorded.

8.3 Verifying Project Eligibility

Verification bodies must affirm a biochar project's eligibility according to the rules described in this protocol. The table below outlines the eligibility criteria for biochar projects. This table does not present all criteria for determining eligibility comprehensively; verification bodies must also look to Section 3 and the verification items list in Table 8.2.

Table 8.1. Summary of Eligibility Criteria for a **Biochar** Project

Eligibility Rule	Eligibility Criteria	Frequency of Rule Application
Start Date	For 12 months following the Effective Date of this protocol, a pre-existing project with a start date on or after may be submitted for listing; after this 12-month period, projects must be submitted for listing within 12 months of the project start date	Once during first verification
Location	All project phases taking place in the United States, Canada, their territories, and/or tribal/First Nation areas	Once during first verification
Performance Standard Test	Performance Standard Test has been met based on project feedstocks	Every verification
Legal Requirement Test	Signed Attestation of Voluntary Implementation form and monitoring procedures for ascertaining and demonstrating that the project passes the legal requirement test	Every verification
Regulatory Compliance	Signed Attestation of Regulatory Compliance form and disclosure of all non-compliance events to verifier; project must be in material compliance with all applicable laws	Every verification

8.4 Core Verification Activities

The Biochar Protocol provides explicit requirements and guidance for quantifying the carbon removals associated with the biochar project. The Verification Program Manual describes the core verification activities that shall be performed by verification bodies for all project verifications. They are summarized below in the context of a biochar project, but verification bodies must also follow the general guidance in the Verification Program Manual.

Verification is a risk assessment and data sampling effort designed to ensure that the risk of reporting error is assessed and addressed through appropriate sampling, testing, and review. The three core verification activities are:

1. Identifying emission sources, sinks, and reservoirs (SSRs)
2. Reviewing monitoring and measurement methodologies
3. Verifying GHG emissions and carbon removal estimates

Identifying emission sources, sinks, and reservoirs
The verification body reviews for completeness the sources, sinks, and reservoirs identified for a project, based on the guidance in Section 4.

Reviewing GHG management systems and estimation methodologies
The verification body reviews and assesses the appropriateness of the methodologies and management systems that the biochar project developer uses to gather data and calculate baseline and project emissions.

Verifying emission reduction estimates
The verification body further investigates areas that have the greatest potential for material misstatements and then confirms whether or not material misstatements have occurred. This involves site visits to the project facility (or facilities if the project includes multiple facilities) to ensure the systems on the ground correspond to and are consistent with data provided to the verification body. In addition, the verification body recalculates a representative sample of the

performance or emissions data for comparison with data reported by the project developer in order to double-check the calculations of carbon removals.

8.5 Biochar Verification Items

The following tables provide lists of items that a verification body needs to address while verifying a biochar project. The tables include references to the section in the protocol where requirements are further specified. The tables also identify items for which a verification body is expected to apply professional judgment during the verification process. Verification bodies are expected to use their professional judgment to confirm that protocol requirements have been met in instances where the protocol does not provide sufficiently prescriptive guidance. For more information on the Reserve's verification process and professional judgment, please see the Verification Program Manual.

Note: These tables shall not be viewed as a comprehensive list or plan for verification activities, but rather guidance on areas specific to biochar projects that must be addressed during verification.

8.5.1 Project Eligibility and CRT Issuance

Table 8.2 lists the criteria for reasonable assurance with respect to eligibility and CRT issuance for biochar projects. These requirements determine if a project is eligible to register with the Reserve and/or have CRTs issued for the reporting period. If any requirement is not met, either the project may be determined ineligible or the GHG reductions from the reporting period (or subset of the reporting period) may be ineligible for issuance of CRTs, as specified in Sections 2, 3, and 6.

Table 8.2. Eligibility Verification Items

Protocol Section	Eligibility Qualification Item	Apply Professional Judgment?
2.2	Verify that the project meets the definition of a biochar project	No
2.3	Verify ownership of the reductions by reviewing Attestation of Title	No
3.2	Verify project start date	No
3.2	Verify accuracy of project start date based on operational records	No
3.2	Verify that the project has documented and implemented a Monitoring Plan	No
3.3	Verify that project is within its 10-year crediting period	No
3.4.1	Verify that the project meets the performance standard test, as described in the Eligible Biochar Feedstocks List. For purpose-grown feedstocks, confirm location of feedstocks production is on non-prime farmland or a reclaimed mining site.	No
3.4.2	Confirm execution of the Attestation of Voluntary Implementation form to demonstrate eligibility under the legal requirement test	No
3.4.2	Verify that the project Monitoring Plan contains a mechanism for ascertaining and demonstrating that the project passes the legal requirement test at all times and that the project passes the test each reporting period.	No
3.5	Verify that the project activities comply with applicable laws by reviewing any instances of non-compliance provided by the project developer and performing a risk-based assessment to confirm the statements made by the project developer in the Attestation of Regulatory Compliance form	Yes

Protocol Section	Eligibility Qualification Item	Apply Professional Judgment?
3.5	Verify that all parties in the chain of custody (from biomass acquisition to end use application) are in regulatory compliance	Yes
6	Verify that the QA/QC activities meet the protocol's QA/QC requirements	No
6.1	Verify that the project meets chain of custody requirements, and that only biochar that meets the requirements are included in credit quantification	No
6.2	Verify that the project meets biochar sampling and testing guidance	No
~~6~~	~~If used, verify that data substitution methodology was properly applied~~	~~No~~
	If any variances were granted, verify that variance requirements were met and properly applied	No

8.5.2 Quantification

Table 8.3 lists the items that verification bodies shall include in their risk assessment and recalculation of the project's GHG emission reductions. These quantification items inform any determination as to whether there are material and/or immaterial misstatements in the project's GHG emission reduction calculations. If there are material misstatements, the calculations must be revised before CRTs are issued.

Table 8.3. Quantification Verification Items

Protocol Section	Quantification Item	Apply Professional Judgment?
4	Verify that all SSRs in the GHG Assessment Boundary are accounted for	No
5.1	Verify that the baseline emissions are assumed to be zero	No
5.2.1.1	Verify that the feedstock production emissions were correctly calculated	No
5.2.1.2	Verify that the feedstock transportation emissions were correctly calculated and are consistent with chain of custody reporting for each feedstock source	No
5.2.1.3	Verify that the feedstock processing emissions were correctly calculated if applicable	No
5.2.1.4	Verify that the auxiliary energy emissions were correctly calculated if applicable	No
5.2.1.5	Verify that the pyrolysis emissions were correctly calculated if applicable	No
5.2.1.6	Verify that the biochar processing emissions were correctly calculated if applicable	No
5.2.1.7	Verify that the biochar transportation emissions were correctly calculated if applicable	No
5.2.2	Verify that the project removals were corrected calculated	No
5.3	Verify that leakage is appropriately accounted for, if applicable	No

8.5.3 Risk Assessment

Verification bodies will review the following items in Table 8.4 to guide and prioritize their assessment of data used in determining eligibility and quantifying GHG emission reductions.

Table 8.4. Risk Assessment Verification Items

Protocol Section	Item that Informs Risk Assessment	Apply Professional Judgment?
6	Verify that the project Monitoring Plan is sufficiently rigorous to support the requirements of the protocol and proper operation of the project	Yes
6	Verify that appropriate monitoring equipment is used to meet the requirements of the protocol	No
6	Verify that the individual or team responsible for managing and reporting project activities are qualified to perform this function	Yes
6	Verify that appropriate training was provided to personnel assigned to GHG reporting duties	Yes
6	Verify that all contractors are qualified for managing and reporting GHG emissions if relied upon by the project developer. Verify that there is internal oversight to assure the quality of the contractor's work	Yes
7.2	Verify that all required records have been retained by the project developer	No

8.5.4 Completing Verification

The Verification Program Manual provides detailed information and instructions for verification bodies to finalize the verification process. It describes completing a Verification Report, preparing a Verification Statement, submitting the necessary documents to the Reserve, and notifying the Reserve of the project's verified status.

9 Glossary of Terms

Accredited verifier	A verification firm approved by the Climate Action Reserve to provide verification services for project developers.
Additionality	Project activities that are above and beyond "business as usual" operation, exceed the baseline characterization, and are not mandated by regulation.
Additive	Mineral-based inorganic material deliberately added to or inadvertently intermixed with feedstocks prior to biochar production.
Carbon dioxide (CO_2)	The most common of the six primary greenhouse gases, consisting of a single carbon atom and two oxygen atoms.
CO_2 equivalent (CO_2e)	The quantity of a given GHG multiplied by its total global warming potential. This is the standard unit for comparing the degree of warming which can be caused by different GHGs.
Contaminant	Based on the International Biochar Initiative definition: An undesirable material in a biochar material or biochar feedstock that compromises the quality or usefulness of the biochar or through its presence or concentration causes an adverse effect on the natural environment or impairs human use of the environment (adapted from Canadian Council of Ministers of the Environment, 2005). Contaminants include fossil fuels and fossil fuel-derived chemical compounds, glass, and metal objects. (IBI, 2012)
Direct emissions	GHG emissions from sources that are owned or controlled by the reporting entity.
Effective Date	The date of adoption of this protocol by the Reserve board: .
Emission factor (EF)	A unique value for determining an amount of a GHG emitted for a given quantity of activity data (e.g., metric tons of carbon dioxide emitted per barrel of fossil fuel burned).
Fossil fuel	A fuel, such as coal, oil, and natural gas, produced by the decomposition of ancient (fossilized) plants and animals.
Greenhouse gas (GHG)	Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), or perfluorocarbons (PFCs).
GHG reservoir	A physical unit or component of the biosphere, geosphere, or hydrosphere with the capability to store or accumulate a GHG that has been removed from the atmosphere by a GHG sink or a GHG captured from a GHG source.
GHG sink	A physical unit or process that removes GHG from the atmosphere.

GHG source	A physical unit or process that releases GHG into the atmosphere.
Global Warming Potential (GWP)	The ratio of radiative forcing (degree of warming to the atmosphere) that would result from the emission of one unit of a given GHG compared to one unit of CO_2.
Indirect emissions	Reductions in GHG emissions that occur at a location other than where the reduction activity is implemented, and/or at sources not owned or controlled by project participants.
Metric ton (t, tonne)	A common international measurement for the quantity of GHG emissions, equivalent to about 2,204.6 pounds or 1.1 short tons.
Methane (CH_4)	A potent GHG consisting of a single carbon atom and four hydrogen atoms.
MMBtu	One million British thermal units.
Mobile combustion	Emissions from the transportation of employees, materials, products, and waste resulting from the combustion of fuels in company owned or controlled mobile combustion sources (e.g., cars, trucks, tractors, dozers, etc.).
Project baseline	A “business as usual” GHG emission assessment against which GHG emission reductions from a specific GHG reduction activity are measured.
Project developer	An entity that undertakes a GHG project, as identified in Section 2.2 of this protocol.
Verification	The process used to ensure that a given participant’s GHG emissions or emission reductions have met the minimum quality standard and complied with the Reserve’s procedures and protocols for calculating and reporting GHG emissions and emission reductions.
Verification body	A Reserve-approved firm that is able to render a verification opinion and provide verification services for operators subject to reporting under this protocol.

10 References

[To be completed for public comment draft]