CLIMATE ACTION RESERVE

Version 1.0 | July 22, 2015

Grassland

Project Protocol

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Released July 22, 2015

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Abbreviations and Acronyms

AGC	Avoided grassland conversion
CARB	California Air Resources Board
CDL	Cropland Data Layer
CDM	Clean Development Mechanism
CFR	Code of Federal Regulations
CH_4	Methane
CO_2	Carbon dioxide
CRP	Conservation Reserve Program
CRT	Climate Reserve Tonne
EPA	U.S. Environmental Protection Agency
GHG	Greenhouse gas
GPP	Grassland Project Protocol
GRP	Grassland Reserve Program
IPCC	United Nations Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
lb	Pound
MODIS	Moderate Resolution Imaging Spectroradiometer
MT (t)	Metric ton (or tonne)
NASA	National Aeronautics and Space Administration
NLCD	National Land Cover Database
N_2O	Nitrous oxide
NRCS	USDA Natural Resources Conservation Service
QCE	Qualified Conservation Easement
Reserve	Climate Action Reserve
SOC	Soil organic carbon
SSR	Source, sink, and reservoir
tCO_2e	Metric ton of carbon dioxide equivalent
UNFCCC	United Nations Framework Convention on Climate Change
USDA	United States Department of Agriculture
USGS	United States Geological Survey

1 Introduction

The Climate Action Reserve (Reserve) Grassland Project Protocol (GPP) provides guidance to account for, report, and verify greenhouse gas (GHG) emission reductions associated with projects that avoid the loss of soil carbon due to conversion of grasslands to cropland, as well as other associated GHG emissions.

The Reserve is an offset registry serving the California cap-and-trade program and the voluntary carbon market. The Reserve encourages actions to reduce GHG emissions and works to ensure environmental benefit, integrity, and transparency in market-based solutions to address global climate change. It operates the largest accredited registry for the California compliance market and has played an integral role in the development and administration of the state's cap-and-trade program. For the voluntary market, the Reserve establishes high quality standards for carbon offset projects, oversees independent third-party verification bodies, and issues and tracks the transaction of carbon credits (Climate Reserve Tonnes or CRTs) generated from such projects in a transparent, publicly-accessible system.[1] The Climate Action Reserve is a private 501(c)(3) non-profit organization based in Los Angeles, California.

Project Developers and Cooperative Developers that initiate avoided grassland conversion (AGC) projects use this document to quantify and register GHG reductions with the Reserve. The protocol provides eligibility rules, methods to calculate reductions, 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 is provided in the Reserve Verification Program Manual 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 associated with an avoided grassland conversion project.[2]

[1] The online registry may be accessed from the Reserve homepage at: www.climateactionreserve.org.
[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

This section describes the GHG reduction project in terms of defining the project site, the related activities, the parties involved, and the possible project structures.

2.1 Background

Grasslands have the ability to both emit and sequester carbon dioxide (CO_2), the primary GHG responsible for human-caused climate change (IPCC, 2014). Grasses and shrubs, through the process of photosynthesis, naturally absorb CO_2 from the atmosphere and store the gas as carbon in their biomass (i.e. plant tissues). As plants die and regrow, some of this carbon is also stored in the soils that support the grassland.

When grasslands are disturbed, such as when the land is tilled for crop cultivation, a portion of the stored carbon oxidizes and decays, releasing CO_2 into the atmosphere. The quantity and rate of CO_2 that is emitted may vary, depending on the particular circumstances of the land and the disturbance. Grasslands function as reservoirs in the global carbon cycle. Depending on how grasslands are managed or impacted by natural and human events, they can be a net source of emissions, resulting in a decrease to the reservoir, or a net sink, resulting in an increase of CO_2 to the reservoir. In other words, grasslands may have a net negative or net positive impact on the climate, depending on their characteristics and management.

Through sustainable management and protection, grasslands can play a positive and significant role to help address global climate change. This protocol is designed to take advantage of grasslands' unique capacity to sequester, store, and emit CO_2 and to facilitate the positive role that grasslands can play to address climate change. The protocol focuses on the avoided conversion of grasslands to cropland. Because conversion is avoided, we can never measure the exact GHG impacts of conversion activities on the project area, and thus cannot know exactly how much carbon would have been released if a particular area of land were converted. To avoid the cost and uncertainty related to site-specific soil sampling and ecosystem modeling, the Reserve has adopted a standardized, probabilistic approach to estimating baseline emissions for AGC projects. This approach is discussed in more detail in Section 5, as well as Appendix B.

2.2 Project Definition

For the purpose of this protocol, the GHG reduction project is defined as the prevention of emissions of GHGs to the atmosphere through conserving grassland belowground carbon stocks and avoiding crop cultivation activities on an eligible project area, as initiated by the recording of a perpetual conservation easement or an eligible transfer of ownership, as described in Section 3.2. The project area must be grassland, as defined below, and it must be suitable for conversion to crop cultivation, as defined in Section 3.3.1.2. The project area must have been in continuous grassland cover for at least 10 years prior to the project start date. The baseline scenario for all AGC projects is conversion to crop cultivation.

For the purposes of this protocol, grassland is defined as an area of land dominated by native or introduced grass species with little to no tree canopy. Other plant species may include woody shrubs, legumes, forbs, and other non-woody vegetation. Tree canopy may not exceed 10% of the land area on a per-acre basis. Areas which exceed this threshold may be eligible to use the Forest Project Protocol.[3]

There must be common ownership for the entire project area (i.e. it must be possible to protect the project area through a single conservation easement). Multiple projects may be managed together as a project cooperative, as described in Section 2.2.2. In addition, the project area must have been privately-owned prior to the project start date, except in the case of non-federal public lands, where:

- The project area is legally able to be converted to cropland without requiring a rulemaking activity; and either
- The public agency in charge of management of the project area must have a legal directive to manage the lands, which include the project area, for profit; or
- A history of such management for profit,[4] including existing conversion, for similarly-situated lands can be documented during the 10 years prior to the start date.

An AGC project may involve seeding, application of organic fertilizer (i.e. manure, compost, etc.), moderate haying, and/or moderate livestock grazing as part of the project activity. Projects may not employ synthetic fertilizer additions or irrigation. CRTs may not be issued for any calendar year during which these activities occur. If grazing is employed in the project scenario, the livestock manure must not be managed in liquid form (i.e. containing less than 20% dry matter and subject to active management), and grazing activities must meet the criteria in Section 6.2. Other recreational or economic activities incidental to the project activities may also occur on the project area (e.g. hunting, bird-watching, light haying), but only to the extent that the incidental activity does not threaten the integrity of the soil carbon stocks and is otherwise compatible with the maintenance of grassland under conservation. The Reserve maintains the right to determine whether an activity is “incidental” to the project or whether the presence of the activity would cause part or all of the project area to be considered an entirely different land use (i.e. not grassland). In those cases, the area used for such activities may not be considered to be part of the project area.

The project lifetime for an AGC project is up to 150 years. This includes the crediting period, which can be up to 50 years (Section 3.4) and the permanence period, which is the 100 years following the crediting period (Section 3.5).

2.2.1 Defining the Project Area

An eligible project area consists of grassland that meets the criteria in Section 3 regarding the threat of conversion to cropland and the lack of legal barriers to such conversion. Only areas that are suitable for conversion to cropland, as defined in Section 3.3.1, are eligible to report under this protocol. The entire project area must be able to be protected by the recording of a single conservation easement (see Section 3.5.1). The area bound by the conservation easement does not need to match the project area. However, the entire project area must be included within the area of the conservation easement. A single project may include multiple legal parcels if all of these conditions can be met. The project does not need to contain every

[3] Information regarding the Reserve’s voluntary forest carbon program can be accessed at: http://www.climateactionreserve.org/how/protocols/forest/. Information regarding the California Compliance Offset Protocol for forest projects can be accessed at: http://www.climateactionreserve.org/how/california-compliance-projects/compliance-offset-projects/.

[4] A practice of carrying out all leasing and sales based on fair market value may be considered “management for profit.”

parcel listed on a deed, and project boundaries do not necessarily need to be coincident with parcel boundaries (i.e. the project area may contain a portion of a parcel).

The geographic boundaries defining the project area must be described in detail at the time a grassland project is listed on the Reserve (see Section 7.2 for details on project documentation). The boundaries must be defined using a georeferenced map, or maps, that displays legal property boundaries, public and private roads, major watercourses (fourth order or greater), topography, towns, and public land survey townships, ranges, and sections or latitude and longitude. The maps should be of adequate resolution to clearly identify the required features. The shapes delineating the project area must contain only areas that meet the eligibility requirements of this protocol. If the project area contains more than one legal parcel, these delineations must also be included. This map will not be publicly accessible.

A Geographical Information System file (GIS shapefile) must be submitted to the Reserve with the project documentation. The shapefile may be converted to a KML file. The acres reported for the project must be based on the acres calculated from the shapefile. The project area can be contiguous or separated into tracts, but must share common ownership and project start date. See Section 5.1 for guidance regarding the stratification of the project area.

After the project has been verified, sections of the project area may be removed (subject to the requirements of Section 5.4), but the project area may not be expanded. New projects may always be added to a project cooperative (see Section 2.3.4).

2.2.2 Project Cooperative

A “project cooperative” or “cooperative” is a collection of two or more individual grassland projects managed by a common entity (referred to as the “Cooperative Developer,” Section 2.3), and which engage in joint monitoring, reporting, and verification (Sections 6.5, 7.6, and 8.1).

2.3 Project Ownership Structures and Terminology

A grassland project can be implemented using various ownership structures. Figure 2.1 displays possible ownership structures for grassland projects, indicating the flow of information and which entities are required to hold Reserve accounts. These are simplified representations; actual project and cooperative structures may be more complex, but the relationships will follow the same approach.

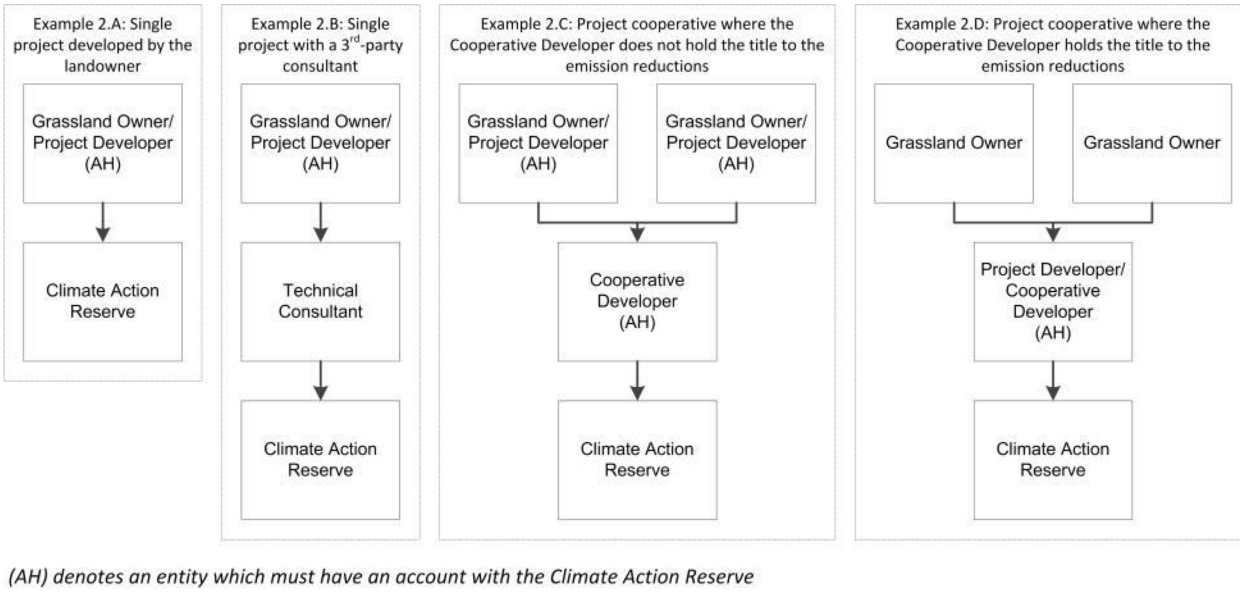

Figure 2.1. Grassland Project Ownership Structures and Terminology

Depending on the project structure, the existence and/or status of certain legal instruments must be verified in order to successfully register a project. The instruments required are described in general below. For every project, the fee owner of the land on which the project is implemented must demonstrate an understanding of the potential participation in a carbon offset program, either through implementing a project himself, or through clear conveyance of the GHG reduction rights associated with the land through a recorded legal instrument as described below. The sections outlined in Table 2.1 should be referred to for specific requirements for each respective legal instrument required. Additional discussion of these legal instruments can be found in Appendix D.

Table 2.1. Guide to Protocol Sections Related to Legal Instruments for Grassland Projects

Legal instrument	Protocol Section(s)
GHG reduction rights contract	2.3.2
Indemnification agreement	2.3.2
Cooperative contract	3.2.1
Conservation easement	2.2, 3.2, 6.2.1.2
Qualified Conservation Easement	3.5.1
Project Implementation Agreement	3.5.2
Reserve attestations (title, voluntary implementation, regulatory compliance)	2.3.2, 3.3.2, 3.6
Instruments associated with concurrently-joined conservation programs	3.3.2.1

2.3.1 Qualifications and Role of Grassland Owners

A Grassland Owner is an individual or a corporation or other legally constituted entity, city, county, state agency, or a combination thereof that has fee ownership and legal control of the land within the project area. A lessee is not a Grassland Owner. Deeded encumbrances that exist within the project area may prevent a fee owner from satisfying the definition of a Grassland Owner. The Grassland Owner is the entity which has the authority to execute and record a conservation easement on the project area. Any unencumbered soil carbon is presumed to be controlled by the fee owner. Notwithstanding this presumption, the Reserve maintains the right to determine whether an individual or entity meets the definition of Grassland Owner.

2.3.2 Qualifications and Role of Project Developers

A Project Developer is the entity which holds legal title to the emission reductions related to the grassland project, and is responsible for undertaking the grassland project and registering it with the Reserve. The Project Developer may be a Grassland Owner, or they may be a third-party entity who has a signed contract with the Grassland Owner conveying title to the emission reductions. The Project Developer may be the holder of the conservation easement. Title to the emission reductions may be conveyed as a part of the easement, or in a separate contract (but in any case such rights must be legally established). If there are any Grassland Owners who are not party to the GHG reduction rights agreement, the Project Developer must also execute an indemnification stating that they will indemnify the Reserve in connection with any claims brought by other grassland owners or would-be grassland owners against the Reserve.[5] The Project Developer shall execute the Project Implementation Agreement (PIA) (see Section 3.5.2). The Project Developer is also responsible for the accuracy and completeness of all information submitted to the Reserve, and for ensuring compliance with this protocol. The Project Developer must have a Reserve registry account[6] and must sign all required legal attestations (e.g. Attestation of Title, Attestation of Voluntary Implementation, and Attestation of Regulatory Compliance). Sample language related to ownership of emission reductions is included below, to be amended to fit each project's specific situation:

> *"TITLE TO CARBON OFFSET CREDITS. The [grantor/grantee- i.e., whichever party to the easement or agreement is the Project Developer] hereby retains, owns, and holds legal title to and all beneficial ownership rights to the following (the "Project Reductions"): (i) any removal, limitation, reduction, avoidance, sequestration or mitigation of any greenhouse gas associated with the Property including without limitation Climate Action Reserve Project No. [___] and (ii) any right, interest, credit, entitlement, benefit or allowance to emit (present or future) arising from or associated with any of the foregoing, including without limitation the exclusive right to be issued carbon offset credits or Climate Reserve Tonnes (CRTs) by a third party entity such as the Climate Action Reserve."*

In all cases, the Project Developer must attest to the Reserve that they have exclusive claim to the GHG reductions resulting from the project. Each time a project is verified, the Project Developer must attest that no other entities are reporting or claiming (e.g. for voluntary reporting or regulatory compliance purposes) the GHG reductions caused by the project.[7] The Reserve will not issue CRTs for GHG reductions that are reported or claimed by entities other than the Project Developer (e.g. Grassland Owners who are not the Project Developer). In the case of project cooperatives, each Project Developer must sign an attestation. Attestations may be submitted by a third party, but must be signed by the Project Developer.

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[5] A sample indemnification agreement is available at: http://www.climateactionreserve.org/how/protocols/grassland/.
[6] Information regarding Reserve accounts and the process for project submittal and registration is available here: http://www.climateactionreserve.org/how/projects/register/.
[7] This is done by signing the Reserve's Attestation of Title form, available at: http://www.climateactionreserve.org/how/program/documents/

Project Developers are ultimately responsible for timely submittal of all required forms and complying with the terms of this protocol. Project Developers may designate a technical consultant or Cooperative Developer to manage the flow of documents and information to the Reserve. The scope of services provided by a technical consultant or Cooperative Developer should be determined by the Project Developer and the relevant management entity and reflected in the contracts between the Project Developer and the relevant management entity.

2.3.3 Qualifications and Role of Cooperative Developers

A "Cooperative Developer" is the entity that manages reporting and verification for a project cooperative, i.e. two or more individual grassland projects that report and verify jointly. A cooperative may consist of grassland projects involving multiple Project Developers. A Cooperative Developer must have an account on the Reserve.

A Cooperative Developer must open a "Project Developer" account on the Reserve and must remain in good standing throughout the duration of the cooperative(s) it manages. Failure to remain in good standing will result in all account activities of the participant projects in the cooperative(s) managed by that Cooperative Developer being suspended until issues are resolved to the satisfaction of the Reserve. In order for a Cooperative Developer to remain in good standing, Cooperative Developers must perform as follows:

- Complete cooperative contracts with Project Developers (see following section on Joining a Cooperative)
- Engage the services of a single verification body for all grassland projects enrolled in the cooperative in any given verification period
- Coordinate the monitoring and reporting activities required by this protocol for all projects in the cooperative(s), observing all cooperative deadlines.
- Coordinate a verification schedule that maintains appropriate verification status for the cooperative. Document the verification work and report to the Reserve on an annual basis how completed verifications demonstrate compliance (see Sections 6.5, 7.6, and 8.1)
- Maintain a Reserve account

As discussed in Section 2.3.2, Project Developers are ultimately responsible for timely submittal of all required forms and complying with the terms of this protocol.

2.3.4 Forming or Entering a Cooperative

Individual grassland projects may join a cooperative by being included in the cooperative's Cooperative Submittal Form[8] (if joining a cooperative at initiation) or by being added through the submission of a New Grassland Project Enrollment Form (if joining once the cooperative is underway).

The individual projects are created in the Reserve system by the Project Developers, but all submittal documentation is submitted by the Cooperative Developer. Each Project Developer will initiate the creation of a new project through their Reserve registry account, through which they will select the appropriate Cooperative Developer from a list.[9] The Cooperative Developer shall initiate the creation of the cooperative through their account in the Reserve registry by

[8] All forms referenced in this section are available at: http://www.climateactionreserve.org/how/program/documents/.
[9] Instructions on project submittal and registration can be accessed at: http://www.climateactionreserve.org/how/projects/register/.

completing the cooperative setup process, confirming the projects that will participate in the cooperative, and submitting a Cooperative Submittal Form. The Cooperative Submittal Form includes the submittal information for all of the individual projects in the cooperative. All documentation related to the cooperative and its participant projects will be submitted by the Cooperative Developer. After successful verification, CRTs will be issued to the accounts of the Project Developers for each project.

Individual grassland projects that have already been submitted to the Reserve may choose to join an existing cooperative by submitting a Cooperative Transfer Form to the Reserve. The Cooperative Developer will also need to submit a New Project Enrollment Form, listing that project area, if the cooperative is already underway. Emission reductions occurring on individual projects or new projects entering a cooperative will be reported as part of the cooperative during the reporting period in which the transfer occurred.[10] The project will begin reporting with the cooperative no earlier than the beginning of the cooperative's current verification period. If the project has already been registered, either as an individual project or as part of another cooperative, reporting under the new cooperative may not include any period of time which has already been reported and verified.

The crediting periods of the individual projects within a cooperative are derived from their individual project start dates, and are not affected by the crediting periods of other projects within the cooperative. All projects within a cooperative must follow the same version of this protocol. If a project that is subject to a more recent version of the protocol wishes to enter an existing cooperative, the rest of the projects in that cooperative must elect to upgrade to the newer version of the protocol.

2.3.5 Leaving a Cooperative

Individual grassland projects must meet the requirements in this section in order to leave or change cooperatives and continue reporting emission reductions to the Reserve. Reporting must be continuous.

Individual Project Developers may elect to leave a cooperative and participate as an individual grassland project for the duration of their crediting period, effective as of the day after the end date of the project's most recently registered reporting period. To leave a cooperative and become an individual grassland project, the Project Developer must submit a Project Submittal Form to the Reserve, noting that it is a "transfer project" and identifying the cooperative from which it is transferring. For projects which leave a cooperative to become an individual project, the deadline for submittal of the subsequent monitoring or verification report (whichever is sooner) will be extended by 12 months beyond the deadline specified in Section 7.4. The Project Developer must submit either a monitoring report or verification report (whichever is due) by this new deadline in order to keep the project active in the Reserve.

To leave one cooperative and enter another cooperative the Project Developer must submit a Cooperative Transfer Form to the Reserve prior to enrolling in the new cooperative. Reporting under the destination cooperative shall continue according to the guidance in Section 7.6.1.

[10] The transfer is considered to have occurred once the Reserve has approved the Cooperative Transfer Form and the New Project Enrollment Form.

2.4 Environmental Best Management Practices

The Grassland Project Protocol is intended to generate GHG reductions through the avoided conversion of grassland to cultivated cropland. The protocol also seeks to limit potential environmental harms caused by project activities through the requirements for regulatory compliance specified in Section 3.6. Environmental enhancements in addition to GHG reductions are beyond the scope of this document. However, the Reserve does strongly encourage Project Developers and Grassland Owners to adopt practices which will provide additional benefits to the grassland ecosystem beyond the GHG reductions. Project Developers and Grassland Owners are encouraged to review and implement the appropriate recommendations for rangeland management developed by the USDA NRCS Conservation Effects Assessment Project (Briske, 2011). It is furthermore recommended that the best management practices relevant to the project area be required as terms of the conservation easement and/or the GHG reduction rights contract.

3 Eligibility Rules

Projects must fully satisfy the following eligibility rules in order to register with the Reserve. The criteria only apply to projects that meet the definition of a GHG reduction project (Section 2.2).

Eligibility Rule I:	Location	→	*Conterminous U.S. and tribal areas*
Eligibility Rule II:	Project Start Date	→	*No more than six months prior to project submission*
		→	*Record a conservation easement or eligible transfer of ownership*
		→	*Cooperative start date options*
Eligibility Rule III:	Additionality	→	*Meet performance standard*
		→	*Exceed legal requirements*
		→	*Satisfy credit and payment stacking requirements*
Eligibility Rule IV:	Project Crediting Period	→	*Emission reductions may only be reported during the crediting period, up to a maximum of 50 years*
Eligibility Rule V:	Permanence	→	*Maintain stored carbon for at least 100 years following issuance of CRTs*
		→	*Employ a Qualified Conservation Easement and Project Implementation Agreement*
Eligibility Rule VI:	Regulatory Compliance	→	*Compliance with all applicable laws*

3.1 Location

Only projects located in the conterminous United States and on U.S. tribal lands are eligible to register reductions with the Reserve under this protocol. All sources within the project boundary (Figure 4.1) must be located within the conterminous United States. Under this protocol, reductions from international projects are not eligible to register with the Reserve. Grassland projects in tribal areas must demonstrate that the land within the project area is owned by a tribe or private entities. Projects are not eligible on organic soils (histosols),[11] including areas identified as wetlands or peatlands.

In addition, the project area must be located on land whose particular combination(s) of Major Land Resource Area (MLRA), soil texture, and prior land use history would result in emissions of soil carbon in the baseline scenario. To be eligible, the grassland project must be able to generate emission reductions through project activities. This is determined by identifying the project strata following the guidance in Section 5.1. The project location is ineligible if there are

[11] Wherever soil types or characteristics are referenced in this protocol, they shall be assumed to describe the upper 20 cm soil layer, unless otherwise specified.

no baseline emission reductions from soil organic carbon in the first 10-year emission factor period.[12]

3.2 Project Start Date

The project start date is defined as the date on which the project area is committed to the continued management and protection of grassland and therefore avoids conversion to cropland.

Commitment to continued management and protection of grassland must be demonstrated by one of the following:

1. Recordation of a conservation easement on the project area, with a provision to maintain the project area as grassland for the protection of soil carbon. The project start date is the date the easement was recorded. If an easement is amended to meet the requirements of a Qualified Conservation Easement (Section 3.5.1), the recordation date of the unamended easement shall be used for purposes of determining the project start date.
2. Transferring of property ownership to a public or private entity with a provision that the project area be maintained as grassland for the protection of soil carbon. The project start date is the date of property transfer. Projects whose start dates rely on the transfer of ownership to an entity other than the Federal Government are still required to record a conservation easement, as described above, prior to the initial registration.
3. For projects participating in a cooperative at the time the project is first registered, either (a) the notarized execution of a cooperative contract between the Project Developer and the Cooperative Developer, as described in Section 3.2.1, or (b) the notarized GHG reduction rights transfer between the Grassland Owner, the easement holder, and the Cooperative Developer (in the case where the Cooperative Developer is the Project Developer).

To be eligible, the project must be submitted to the Reserve no more than six months after the project start date, unless the project is submitted for listing prior to July 22, 2016.[13] Until that date, projects with start dates as early as July 22, 2013 are eligible if they meet one of the start date scenarios above.

In no case is a new project (i.e. a project that has never been submitted to an offset project registry or otherwise claimed emission reductions in any way) with a start date prior to July 22, 2013 eligible under this protocol. Projects that have previously been submitted to and accepted by another offset project registry (transfer projects) may be eligible with a start date prior to July 22, 2013. Start date requirements for those projects is described in the Reserve Program Manual.[14] Projects may always be submitted for listing by the Reserve prior to their start date.

[12] Certain parameters required for project eligibility and quantification are contained in a separate document, “Grassland Project Parameters,” available at: http://www.climateactionreserve.org/how/protocols/grassland/.
[13] 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/.
[14] Please refer to the most current version of the Reserve Program Manual, available at: http://www.climateactionreserve.org/how/program/program-manual/.

3.2.1 Cooperative Project Start Dates

Each project is allowed to establish a project start date based on the initial recordation of the easement or an eligible transfer of ownership related to the project area. For projects that participate in a cooperative at the time they are first registered, the following options are also available (unless they are entering into a concurrent legally binding agreement, as described in Section 3.3.2.1). Any project participating in a cooperative that is also entering into a concurrent legally binding agreement to conserve the project area as grassland, pursuant to Section 3.3.2 Legal Requirement Test, Section 3.3.2.1 Requirement for Concurrent Legally Binding Agreements, and/or Section 3.3.3 Ecosystem Services and Credit Stacking, must use the date of easement recordation as the project start date.

To be eligible for these start date options, the Project Developer must execute a cooperative contract between the Project Developer and the Cooperative Developer and have it notarized prior to registration.[15]

1. **Projects joining the cooperative at its initiation**[16]
   The earliest allowable project start date for a group of projects joining a cooperative at the cooperative's initiation is the date of the first recorded easement of that group of projects. Each project may elect to use either its date of easement recordation, or its notarized date of execution of the cooperative contract or the GHG reduction rights agreement, provided that the date is not before the earliest allowable start date. If the date of a notarized contract is used to determine the start date, it must occur prior to the recordation of the easement for that project.

   For Cooperative Developers who wish for all initial projects in the cooperative to share the same start date, they would schedule all of their contracts to be executed on the same day of the recording of the first conservation easement of that cooperative.

2. **New projects enrolling after the initial verification of the cooperative**
   New Projects joining an existing cooperative have the same options as projects that were part of the cooperative at its initiation, provided that the verification schedule of the cooperative allows for the new project to meet all protocol requirements, specifically the initial verification deadline.

3. **Existing projects joining the cooperative using a cooperative transfer form**
   An existing project that joins a cooperative using a cooperative transfer form must retain its original project start date. If necessary, sub-annual reporting may be used to bring an existing project up to the verification schedule of the cooperative.

[15] If Project Developer is not the fee simple Grassland Owner, the Project Developer must also be able to demonstrate clear ownership of the GHG reduction rights through a GHG reduction rights contract with the fee simple Grassland Owner duly executed before or at the time of the notarized execution of the cooperative contract. If the Project Developer is the Cooperative Developer, then the GHG reduction rights contract may be used in lieu of a cooperative contract.

[16] Projects are considered to be "initial" members (or "joining at initiation") of a cooperative if they are included in the initial verification of the cooperative. A project included on the Cooperative Submittal Form is assumed to be an initial member of the cooperative until the completion of the initial verification of the cooperative, at which time the list of initial projects is officially identified.

3.3 Additionality

The Reserve strives to register 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 criteria to be considered additional:

1. The Performance Standard Test
2. The Legal Requirement Test
3. Limits on payment and credit stacking

3.3.1 The Performance Standard Test

Projects pass the Performance Standard Test (PST) by meeting a performance threshold, i.e. a standard of performance applicable to all grassland projects, established by this protocol. The PST is applied at the time a project applies for registration with the Reserve. The PST for a grassland project has two parts:

1. Financial threshold
2. Suitability threshold

3.3.1.1 Financial Threshold

The Reserve has determined that there is a financial barrier to project activities due to the economic incentives to convert grassland to cropland. Rather than have each project demonstrate the existence of this barrier individually, the Reserve has developed a standardized threshold for financial additionality, referred to as the cropland premium. The cropland premium is determined as the percentage difference in the value (represented by land rental rates in $/acre) of cropland over pastureland in the county where the project is located. Project eligibility is based on the cropland premium for the county where the project is located, based on the conditions below:

1. Projects in counties with a cropland premium greater than 100% are eligible without any discount for uncertainty
2. Projects in counties with a cropland premium greater than 40% but less than 100% are eligible, but must apply a discount to their baseline emissions (see Section 5.2.5 for a description of DF_{conv}), unless the county can meet the requirements of step 4
3. Projects in counties with a cropland premium less than 40% are not eligible, unless the project meets the requirements of step 4
4. Projects in counties that meet the description of step 2 or step 3, or which are identified in the tables as having “No Data,” have the option to obtain a certified appraisal to determine a site-specific cropland premium, following the guidelines below for the appraisal process.

If more than 10% of the project area is located in a particular county, then eligibility must be assessed separately for that county. If the county is not eligible, then that portion must be removed from the project area. If less than 10% of the project area is located in an ineligible county, that area may be included in the project area as long as it is physically contiguous with a portion of the project area which is located in an eligible county. A document and a spreadsheet with the eligibility status of each county are available from the Reserve website.[17] A paper copy of this list will be provided upon request. The standardized financial threshold will be updated annually and published in the 4th quarter of each calendar year, to apply to projects submitted on or after January 1st of the following year. Figure 3.1 displays the county eligibility for project submitted during the calendar year 2015. For counties which are identified as having no data, a Project Developer may request that the Reserve examine the data for surrounding counties and determine whether the county may be considered eligible (and the appropriate value for DF_{conv}, if applicable). Additional information regarding the development of this threshold can be found in Appendix A.

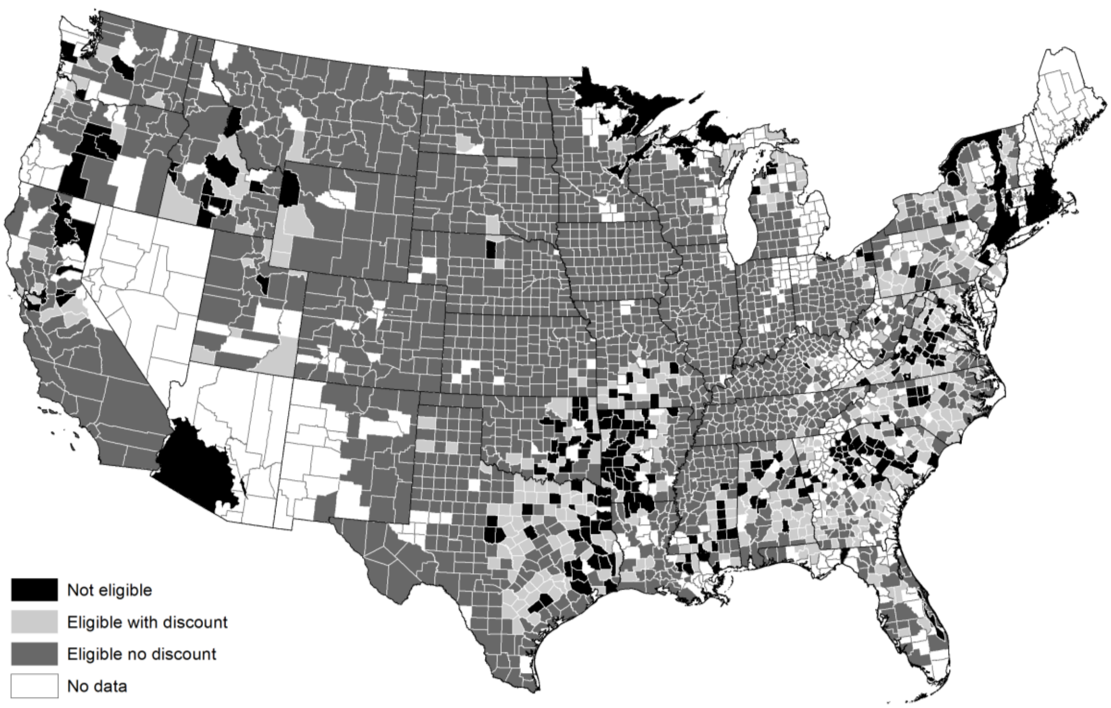

Figure 3.1. County Eligibility Map for Projects Submitted during the Calendar Year 2015

Appraisal Option

If using step 4 above, a project may satisfy the financial threshold if the Project Developer provides an up-to-date[18] real estate appraisal for the project area (as defined in Section 2.2.1) indicating the following:

1. *The project area is suitable for conversion to cropland*. The appraisal must clearly indicate how the physical characteristics of the project area are suitable for crop cultivation, including the particular crops expected to be grown.
2. The appraisal must conform with the following minimum standards[19]:

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[17] Certain parameters required for project eligibility and quantification are contained in a separate document, “Grassland Project Parameters,” available at: http://www.climateactionreserve.org/how/protocols/grassland/.
[18] An appraisal will be considered “up-to-date” if it is finalized no more than 6 months before or after the project start date.
[19] Adapted from Sections 5096.501 and 5096.517, Public Resources Code, State of California.

a. Appraisal reports shall be prepared and signed by a third-party, Licensed or Certified Real Estate Appraiser in good standing.
b. Appraisal reports shall include descriptive photographs and maps of sufficient quality and detail to depict the subject property and any market data relied upon, including the relationship between the location of the subject property and the market data. The appraisal must provide a map that displays specific portions of the project area that are suitable for crop production. (For example, an appraisal that identified corn production as an alternative land use must specify the approximate acres suitable for both the crops and any related roads, buildings, or other infrastructure.)
c. Appraisal reports shall include a complete description of the subject property land, site characteristics and improvements. Valuations based on a property's development potential shall include:
    i. Verifiable data on the conversion potential of the land (e.g. Certificates of Compliance, Tentative Map, Final Map, approval for crop insurance, new breakings request form).
    ii. A description of what would be required for a conversion to cropland to proceed (e.g. legal entitlements, infrastructure).
    iii. Presentation of evidence that sufficient demand exists, or is likely to exist in the future, to provide market support for the conversion to cropland.
    iv. The appraisal must demonstrate that the slope of project area land is compatible with crop production by identifying two areas with similar average slope conditions to the project area within the project's Major Land Resource Area (MLRA) that are currently in crop cultivation.
    v. The appraisal must also provide:
        1. Evidence of soil suitability for the type of expected agricultural land use.
        2. Evidence of water availability for the type of expected agricultural land use.
d. Appraisal reports shall include a statement by the appraiser indicating to what extent land title conditions were investigated and considered in the analysis and value conclusion.
e. Appraisal reports shall include a discussion of implied dedication, prescriptive rights or other unrecorded rights that may affect value, indicating the extent of investigation, knowledge, or observation of conditions that might indicate evidence of public use.
f. Appraisal reports shall include a separate valuation for ongoing grassland management prepared and signed by a certified or registered professional qualified in the field of specialty interest. This valuation shall be reviewed and approved by a second qualified, certified or registered professional, considered by the appraiser, and appended to the appraisal report. The valuation must identify and incorporate all legal constraints that could affect the valuation of the ongoing grassland management.

g. The appraisal must be conducted in accordance with the Uniform Standards of Professional Appraisal Practice[20] and the appraiser must meet the qualification standards outlined in the Internal Revenue Code, Section 170 (f)(11)(E)(ii).[21]

3. *The alternative land use for the project area has a higher market value than maintaining the project area for sustainable grassland management, such that it meets the financial additionality threshold.* The appraisal for the property must provide an estimated fair market value for the rental rate (in US$ per acre per month) for the current grassland use condition of the project area (considering the land to be encumbered and thus unable to be converted to cropland) and an estimated fair market value of the rental rate for the anticipated use the project area as cropland. The appraisal must identify whether or not irrigation is considered in the valuation (or, alternatively, may provide estimations both with and without irrigation). The difference between the rental rate for cropland and the rental rate for grassland, divided by the rental rate for grassland, is the cropland premium for the project area. Eligibility will then be determined according to the thresholds as outlined in the beginning of Section 3.3.1.1.

3.3.1.2 Suitability Threshold

The project area must be suitable for conversion to cropland. Suitability is demonstrated by determining the Land Capability Classification[22] (LCC) for the soil map units that are contained within or intersect the project area. At least 75% of the total area contained within the project boundary must be identified as Class I, II, III, or IV soils. While Class IV is considered to be the highest class which is still suitable for agriculture, recent trends suggest that grasslands on Class V and VI soils are experiencing a high rate of conversion to cropland (Lark, Salmon, & Gibbs, 2015). Thus, portions of the project area may be identified as Class V or VI soils as long as the total area of these soils does not exceed 25% of the total project area. Determination of the area of each LCC within the project area may be done through the NRCS Web Soil Survey, or other tools.

The Soil Survey Geographic Database (SSURGO) contains LCC for both irrigated and non-irrigated land uses. The Project Developer will refer to the non-irrigated LCC to determine eligibility for the project area. If a Project Developer would like to use the irrigated LCC for a project, they must provide evidence that the project area would have access (both legal and physical) to irrigation in the baseline scenario. This can be demonstrated by one or more of the following methods, subject to the verifier's professional judgment:

- Comprehensive assessment of the existence of available groundwater,[23] and the legal and economic feasibility of the Grassland Owner to access it from within the project area
- Documentation of the current availability of water rights and/or permits for the project area on or around the project start date

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

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

[22] United States Department of Agriculture, Soil Conservation Service. *Agriculture Handbook No. 210: Land-Capability Classification*. (1961). Available online at http://naldc.nal.usda.gov/catalog/CAT10310193.

[23] The groundwater assessment should be completed by an appropriately-trained professional, such as a Professional Geologist, Professional Engineer, or Certified Hydrogeologist.

- Documentation of installation of new irrigation on lands within the project county within the 24 months prior to the project start date
- Evidence of ongoing irrigation practice on other parcels within the county

3.3.2 The Legal Requirement Test

All projects are subject to a Legal Requirement Test to ensure that the GHG reductions achieved by a project would not otherwise have occurred due to federal, state, or local regulations, or other legally binding mandates. The Legal Requirement Test for grassland projects involves three parts to ensure the project activity is allowed but not compelled:

1. There must be no federal, state, or local regulation for the project area to be maintained as grassland, either pre-existing or subsequent, or other pre-existing legally binding mandate, agreement, contract[24], deed restriction or deeded encumbrance[25] for the project area to be maintained as grassland (other than the easement that is enacted for the project); and,
2. There must be no zoning, permitting, ownership, or other legal obstacle to the conversion of the project area to cropland; and,
3. There must be no federal, state, or local regulation which would prohibit ongoing management of the project area as cropland.

Parts 1 and 2 are assessed as of the project start date. Part 3 is assessed on an ongoing basis following the project start date. Voluntary agreements that can be rescinded, such as rental contracts, are not considered legal requirements. Temporary or emergency restrictions or regulations shall be assessed with regard to the Legal Requirement Test so long as they constitute a legally binding mandate, as described in this section. If a temporary legal restriction would violate parts 1 and/or 2 above, the project may delay implementation until such time that the project may pass the Legal Requirement Test. If a temporary legal restriction would violate part 3 above, the project will be ineligible to receive CRTs for the period of time during which the regulation is effective.

Habitat Conservation Plans (HCPs) and Safe Harbor Agreements (SHAs) are voluntary agreements that shield landowners from certain liabilities under the Endangered Species Act. Agreements of this nature that were approved more than 6 months prior to the project's start date are considered to be pre-existing legally binding agreements.[26] Agreements of this nature that are approved no more than 6 months prior to the project's start date and that satisfy Section

[24] An agreement that can be enforced specifically, that is, where a party to the agreement (who is not participating as a "Grassland Owner") can prevent the physical breaking of the grassland, is considered a binding legal requirement.
[25] Unless all parties with a potential claim to soil carbon ownership participate in the project as Grassland Owners, per Section 3.2, any pre-existing encumbrance or restriction or any other recorded agreement, must expressly and unequivocally assign soil carbon ownership and control to the participating Grassland Owner(s) and/or expressly permit the participating Grassland Owner(s) and Project Developer(s) to undertake a soil carbon offset project on the project area. Any subsequent legally binding agreement must be made subordinate to the PIA (if applicable) and project-related conservation easement; the terms of a subsequent legally binding agreement must not be incompatible with an AGC project. See Sections 2.3.2 and 3.5.1 for more information on eligibility requirements regarding title recordings and encumbrances.
[26] While voluntary in nature, the penalties for terminating HCPs or SHAs are such that they are effectively legally-binding in the opinion of the Reserve. The allowance for agreements approved within 6 months of the project start date is based on the opinion that this represents a "concurrent" activity.

3.3.2.1 are not considered pre-existing legally binding agreements for the purpose of the Legal Requirement Test.[27]

Any agreement that serves to generate credits or payments for ecosystem services derived from the land is subject to the eligibility requirements in Section 3.3.3.

Deeded encumbrances, such as conservation easements, may effectively control soil carbon. Deeded encumbrances which are enacted prior to the Project Start Date are considered legally binding mandates for the purposes of the Legal Requirement Test.

To satisfy the Legal Requirement Test, the Project Developer must submit a signed Attestation of Voluntary Implementation form[28] as part of the verification activities for the initial verification (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.

3.3.2.1 Requirements for Concurrent Legally Binding Agreements

A Grassland Owner may concurrently enter into a legally binding agreement related to ecosystem services or protection on the project area, subject to Sections 3.3.2 for liability shielding agreements and/or Section 3.3.3 for ecosystem services or protection credit and payment stacking, under the following conditions. For liability shielding programs, i.e. HCPs and SHAs, an agreement is considered concurrently entered into if the legal agreement is approved no more than 6 months prior to the project start date. For credit and payment stacking programs, the agreement is considered concurrently entered into if the easement required by the ecosystem program serves both the ecosystem services program and the start date requirement of the GPP.

The Grassland Owner must ensure that the agreement, and/or the program under which the agreement is authorized, provides sufficiently clear language to demonstrate the legal additionality of the grassland project. Specifically, the agreement must make explicit that the Grassland Owner has the right to use the land covered by the agreement for the purposes of participating in a carbon offset market. The Reserve maintains the right to determine whether this issue is clear.

For agreements that require land to be put under perpetual conservation easement, the easement may also serve the requirements of a grassland project so long as the easement conforms to the requirements of Section 3.2. For agreements that require at least one perpetual conservation easement but allow for multiple subsequent easements, each easement should be evaluated individually. If any easement does not conform to Section 3.2, the portion of the land covered by that easement is ineligible as a project area.

3.3.3 Ecosystem Services Credit and Payment Stacking

When multiple ecosystem services credits or payments are sought for a single activity on a single piece of land, with some temporal overlap between the different credits or payments, it is referred to as "credit stacking" or "payment stacking," respectively (Cooley & Olander, 2011).

[27] While an agreement may not violate the Legal Requirement Test, an easement or other deed restriction associated with the performance of that agreement may be a pre-existing legal requirement, and therefore disqualify certain portions, if not all, of the agreement area. See Section 3.3.2.1.
[28] Attestation forms are available at http://www.climateactionreserve.org/how/program/documents/.

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). 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 issuing mitigation credits 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.

Any type of conservation or ecosystem service payment or credit 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.

3.3.3.1 Credit Stacking

The Reserve identified two mitigation credit market opportunities that need to be assessed as part of the eligibility of a grassland project. These markets credit the same activity on the same acreage as a grassland project: permanently conserving grassland.

Endangered Species Habitat Credits

Endangered species habitat credits can be generated through habitat conservation banks. These conservation banks are authorized under Section 10 of the Endangered Species Act (ESA) to restore, create or otherwise protect endangered species habitat (U.S. Fish and Wildlife Service, 2003). Section 10 allows landowner-developers to perform certain actions that would otherwise result in an illegal taking of an endangered species or its habitat under Section 9 of the ESA, provided that they receive and comply with an incidental take permit from the U.S. Fish and Wildlife Services (FWS)[29]. The permit requires the landowner-developer to mitigate the negative impacts of the activity on the habitat, and may allow the landowner-developer to achieve this mitigation by purchasing – or generating – endangered species habitat credits from habitat conservation banks.

In order to establish a conservation bank and generate endangered species credits, FWS requires landowner-bankers to enter into a conservation bank agreement with the FWS and other relevant government agencies, and to record a perpetual conservation easement on the land covered by the conservation bank. A Grassland Owner can concurrently seek the establishment of a conservation bank on the project area, but the Grassland Owner must ensure that both the conservation bank agreement and the perpetual easement provide sufficiently clear language to demonstrate the additionality of the grassland project, i.e. that potential revenues from the grassland project were considered at the time of the negotiation of both of these agreements.

The date of the easement recordation is subject to the start date requirements in Section 3.2 and the easement itself is subject to the easement requirements in Section 3.2. The conservation bank agreement is not considered to be a pre-existing legal requirement for the purposes of the Legal Requirement Test so long as it satisfies Section 3.3.2.1.

Furthermore, FWS specifies that land used to establish conservation banks must not be previously designated for conservation purposes.[30] It is thus reasonable to assume that FWS

[29] 16 USC Section 1539 (2009).
[30] *Ibid*.

would not approve a conservation bank and issue endangered species habitat credits to lands already engaged in a grassland project. However, it is ultimately the decision of FWS if such subsequent credit stacking is allowed.

Wetland Credits

Under the guidelines established for Section 404 of the Clean Water Act, developers may impact a wetland if those impacts are offset through the restoration, creation, enhancement or preservation of another wetland elsewhere. The Army Corps of Engineers-led Interagency Review Team (IRT)[31] may issue a Department of Army (DA) permit to authorize such actions subject to the creation of a wetland mitigation bank.[32] In some cases, wetland mitigation banks may include and credit the preservation of upland habitat that could be eligible under this protocol.

Similar to conservation banks, the acreage covered by mitigation banks is required to be protected in perpetuity.[33] A Grassland Owner can concurrently seek the establishment of a mitigation bank on the project area, but the Grassland Owner must ensure that both the mitigation bank agreement and the perpetual easement provide sufficiently clear language to demonstrate the additionality of the grassland project, i.e. that potential revenues from the grassland project were considered at the time of the negotiation of both of these agreements.

The date of the easement recordation is subject to the start date requirements in Section 3.2 and the easement itself is subject to the easement requirements in Section 3.2. The mitigation bank agreement is not considered to be a pre-existing legal requirement for the purposes of the Legal Requirement Test so long as it satisfies Section 3.3.2.1.

Furthermore, federal law states that under no circumstances may the same credits be used to provide mitigation for more than one permitted activity but that, where appropriate, mitigation banks may be designed to holistically address requirements under multiple programs and authorities for the same activity.[34] It is then reasonable to assume that the IRT would not approve a mitigation bank and issue wetland credits to lands already engaged in a grassland project. However, it is ultimately the decision of the IRT if such subsequent credit stacking is allowed.

3.3.3.2 Payment Stacking

The Reserve has identified two general types of payments that support the grassland activities being credited under this protocol: “landscape-scale” payments and “enhancement” payments. The majority of these payments are available via programs implemented by the USDA Natural Resource Conservation Service (NRCS). NRCS expressly allows the sale of environmental credits from enrolled lands,[35] but does not provide any further guidance on ensuring the additional environmental benefit of any payment for ecosystem service stacked with an NRCS payment.

[31] The Army Corps of Engineers is the chair; other members can be EPA, FWs, NRCS, NOAA and other federal, state, tribal and local agency representatives
[32] Code of Federal Regulations, Title 33, Part 332 (33 CFR 332)
[33] 33 CFR 332.3(h)(1)(v) .
[34] 33 CFR 332.3 (j)(1)(ii).
[35] EQIP, 7 CFR §1466.36; CSP, 7 CFR §1470.37.

Landscape-Scale Payments

Landscape-scale payments generally come from land conservation programs that prevent grazing and pasture land from being converted into cropland, used for urban development, or developed for other non-grazing uses. Participants in these programs voluntarily limit future development of their land through the use of long-term contracts or easements, and payments are generally made based on the value of the land being protected. Thus, these payments are incentivizing the same project activity as this protocol. Examples of landscape-scale payments include:

- NRCS Grasslands Reserve Program (2008 Farm Bill)
- NRCS Conservation Reserve Program (2008 Farm Bill)
- NRCS Farm and Ranch Lands Protection Program (2008 Farm Bill)
- NRCS Agricultural Conservation Easement Program (2014 Farm Bill)
- Conservation easement support offered by non-governmental organizations such as Ducks Unlimited, The Nature Conservancy and the Trust for Public Land (which are often themselves funded by government programs)

If a Grassland Owner concurrently seeks a landscape-scale payment on the project area, any easement or agreement on the project area is subject to the start date requirements in Section 3.2 and the Legal Requirement Test in Section 3.3.2.

Furthermore, under the current rules of government funded programs the recordation of a new permanent conservation easement in order to initiate a grassland project would disqualify the lands from continued participation in any NRCS payment program. Therefore, the Reserve does not expect lands participating in such programs will have the opportunity to stack payments once the project easement has been recorded, or subsequently stack such payments.

Because every available landscape-scale payment is not comprehensively addressed by the protocol at this time, the Project Developer must disclose any such payments to the verifier and the Reserve on an ongoing basis. The Reserve maintains the right to determine if payment stacking has occurred and whether or not it would impact project eligibility.

Enhancement Payments

Enhancement payments provide financial assistance to landowners in order to implement discrete conservation practices that address natural resource concerns and deliver environmental benefits. For government-funded enhancement payments, participants sign short-term contracts and receive annual cost-share payments specific to the conservation practice they have implemented. Examples of relevant enhancement payments include:

- NRCS Environmental Quality Incentives Program (2014 Farm Bill)
- NRCS Conservation Stewardship Program (2014 Farm Bill)
- NRCS Continuous Conservation Reserve Program (2008 Farm Bill)
- NRCS Wildlife Habitat Incentive Program (2008 Farm Bill)

The practices that are compensated for by the programs above can only occur on land that is being maintained as grassland; however the payment contracts do not purport to pay for the preservation of the grassland, only its enhancement. Furthermore, the programs do not, in practice, sufficiently incentivize the preservation of grassland, much less compensate for the permanent conservation of grassland. Because of this, Grassland Owners may pursue enhancement payments without restriction.

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.

3.4 Project Crediting Period

The baseline for any grassland project registered under this protocol is valid for 50 years. This means that a registered grassland project is eligible to receive CRTs for GHG reductions quantified using this protocol, and verified by Reserve-approved verification bodies, for a period of up to 50 years following the project's start date. Certain strata may not generate baseline emissions for the full 50 years (as evidenced by a baseline emission factor for organic carbon loss equal to zero for a particular emission factor period), in which case the maximum crediting period will be less than 50 years. In the case of project cooperatives, project crediting periods will be tied to each individual grassland project within the cooperative and their respective start dates. Thus, unless all of the projects in the cooperative share the same start date, there will not be a single crediting period applicable to the entire cooperative.

Projects may elect to end their crediting period at any time. Any CRTs that have been issued are subject to the permanence requirements described in Section 3.5. Any project that wishes to end its crediting period must notify the Reserve prior to the next monitoring or reporting deadline, as determined in Section 7.4. If a project chooses to end its crediting period, no future emission reductions may be reported. If a project would like to forgo credits for a period of time in order to delay verification, this is considered a Zero Credit Reporting Period.[36]

3.5 Requirements for Permanence

To validly offset GHG emissions, the reversible emission reductions credited under this protocol must be permanent. An emission reduction is considered reversible if it is related to carbon which remains stored in a carbon pool, such as soil organic carbon. An example of a non-reversible emission reduction on a grassland project would be the avoided N_2O emissions related to baseline fertilizer use. For the purposes of this protocol, an emission reduction is considered "permanent" if the quantity of carbon associated with that reduction is stored for at least 100 years following the issuance of a credit for that reduction. Once an emission reduction is considered permanent, it is no longer considered reversible. For example, if CRTs are issued to a grassland project in year 24 following its start date, soil carbon in the project area must be maintained through at least year 124. To meet this requirement, Project Developers must monitor and verify a grassland project for a minimum period of 100 years following the issuance of any CRT for GHG reductions achieved by the project, unless the project is terminated. Failure to maintain ongoing monitoring and verification may result in the automatic termination of the project. Note that this means that monitoring and verification for a project must continue even after the end of the project's crediting period. The period of time after the project crediting period has ended and before the minimum time commitment has been met is referred to as the "permanence period."

If carbon is released before the end of the 100-year period after a CRT is issued, the release is termed a "reversal." A reversal occurs if stored carbon is actually released through a disturbance of the project area, or is deemed to be released through termination of the project

[36] See the Reserve Program Manual, available at: http://www.climateactionreserve.org/how/program/program-manual/.

or a portion of the project. Reversals may impact only a portion of the project area or the entire project area.

This protocol distinguishes between two categories of reversals, avoidable and unavoidable, and specifies separate remedies for each.

An avoidable reversal occurs if:

1. The Project Developer voluntarily terminates the project prior to the end of the 100-year time commitment. A Project Developer may voluntarily terminate the entire project, or a portion of the project area. If only a portion is terminated, then the reversal is considered to affect only the terminated area.
2. There is a breach of certain terms described within the Project Implementation Agreement (see Section 3.5.1, below). Such a breach will result in the entire project being automatically terminated.
3. The Project Developer prematurely ceases ongoing monitoring and verification activities. Monitoring, reporting, and verification requirements are described in Sections 6, 7, and 8. Cessation of monitoring and verification will result in the entire project being automatically terminated.
4. Any activity occurs on the project area that leads to a significant disruption of soil carbon. Examples include, but are not limited to, cropping activities (conversion to cropland), eminent domain, mining or drilling activities, or installation of wind turbines.
5. A natural disturbance occurs to the soil carbon in the project area, and the Reserve determines that the disturbance is attributable to the Grassland Owner's or Project Developer's negligence, gross negligence, or intentional mismanagement of the project area as grassland.

Avoidable reversals must be compensated for by the Project Developer, as prescribed in Section 5.4.

To ensure that the permanence obligations are guaranteed for the duration of the minimum time commitment, projects are required to employ a Qualified Conservation Easement (QCE) (Section 3.5.1) and a Project Implementation Agreement (PIA) (Section 3.5.2).

For the purposes of this protocol, both QCEs and the PIA must be effective for 100 years following the issuance of CRTs. However, it may be the case that state law for the project area places limitations on the term length for contracts of this sort. For example, in North Dakota, property easements and restrictions are subject to a maximum limit of 99 years.[37] CRTs will only be issued for periods of time for which the required easement(s) will be effective for at least 100 years following the year in which the emission reduction was generated. For projects where length of property restrictions is limited by state law, CRTs issued for any given reporting period shall be held by the Reserve for a period of time based on the contract length. These CRTs shall be released following a subsequent renewal of the property restrictions such that the restrictions will be effective through a date that is at least 100 years after the end of the relevant reporting period.

[37] North Dakota Century Code section 47-05-02.1, "Requirements of easements, servitudes, or nonappurtenant restrictions on the use of real property." Accessible at: http://www.legis.nd.gov/cencode/t47.html.

For example, if a verification period covers two 12-month reporting periods, and a 99-year easement is recorded at the end of the verification period, CRTs will only be issued for the first reporting period. CRTs for the second reporting period shall be withheld until such time as the easement is rerecorded, thus ensuring permanence for at least 100 years from the end of the second reporting period.

3.5.1 Qualified Conservation Easements

A conservation easement is required for all grassland projects except for those where ownership of the project area is transferred to the Federal Government. The area bound by the conservation easement does not need to match the project area. However, the entire project area must be included in the area of the conservation easement. A Qualified Conservation Easement (QCE) is one whose terms prevent the conversion of the project area from grassland to another land use, such that avoidable reversals are sufficiently precluded as long as the easement is enforced. For example, whereas a basic conservation easement may only restrict the subdivision and/or development of the project area, a QCE would also restrict activities such plowing and farming, which could release carbon stored in the soil. The QCE may allow for other activities, such as road or building construction, on the land bound by the easement. However, insofar as these activities would result in a land use other than grassland, the areas where they are allowed should be specified in the QCE and subsequently excluded from the project area. Alternatively, the QCE may make reference to the carbon project and simply specify that any non-grassland land use must occur outside of the specified project area.

There are additional provisions for project conservation easements that the Reserve strongly encourages, but does not require. For enhanced transparency and legal clarity, the conservation easement should explicitly (1) refer to, and incorporate by reference, the terms and conditions of the PIA and the GHG reduction rights agreement, thereby binding both the grantor and grantee—as well as their subsequent assignees—to the terms of the agreements for the full duration of the grassland project's minimum time commitment, as defined in Section 3.5 of this protocol; and (2) make all future encumbrances and deeds subject to the PIA.[38] It is also recommended that the QCE incorporate and require environmental best management practices for rangeland management (Section 2.4).

3.5.2 Project Implementation Agreement

Permanence obligations must be guaranteed through a legal agreement that obligates the Project Developer to conduct monitoring activities on the project area for the required period of 100 years following CRT issuance, and to compensate for avoidable reversals that occur during that period. For grassland projects this agreement is known as the Project Implementation Agreement (PIA).[39] Requirements for monitoring and reporting activities during the permanence period are detailed in Section 7.5.

The PIA is an agreement between the Reserve and a Project Developer setting forth: (i) the Project Developer's obligation (and the obligation of its successors and assigns) to comply with the Grassland Project Protocol, and (ii) the rights and remedies of the Reserve in the event of

[38] The approach to subordination of the PIA will impact the project's contribution to the risk buffer pool, as described in Section 5.4.3.

[39] As an example, the current PIA for Reserve forest projects is available at: http://www.climateactionreserve.org/how/protocols/forest/. A separate version of this document will be developed for grassland projects and made available on the grassland protocol webpage: http://www.climateactionreserve.org/how/protocols/grassland/.

any failure of the Project Developer to comply with its obligations. The PIA must be signed by the Project Developer before a project can be registered with the Reserve. The PIA is executed and submitted after the Reserve has reviewed the verification documents and is otherwise ready to register the project. It is not possible to terminate the PIA for only a portion of the project area; however an amended PIA may be executed that reflects a change to the project area as provided for by the exceptions to the minimum time commitment at the beginning of this section.

There are two types of PIAs available to a grassland Project Developer:

Contract PIA

A Contract PIA is a contract between the Project Developer and Reserve whereby the Project Developer agrees to the requirements of the protocol, including but not limited to monitoring, verification, and compensating for reversals. The PIA will not restrict the transferability of the specific CRTs issued, but will hold the Project Developer to the compensation requirements of Section 5.4. By the terms of the PIA, the contract will be satisfied upon the Project Developer's full performance of the requirements of this protocol (e.g. monitoring and verifying permanence for 100 years following CRT issuance). The PIA will be executed at the completion of every verification prior to or at the time of CRT issuance. The Contract PIA is not a public document.

Recorded PIA

In the case where the Project Developer is the Grassland Owner, or where the Grassland Owner is willing to record the PIA on the deed to the property, to the Project Developer may employ a Recorded PIA. This is a contract between the Project Developer and the Reserve which is recorded on the deed to the property and binds the Project Developer and Grassland Owner to the terms of the protocol. This version of the PIA does not grant the Reserve a security interest, but rather grants the Reserve the ability to enforce the protocol requirements on the project area. The Recorded PIA is publicly available from the records office of the county in which the project is located.

3.6 Regulatory Compliance

As a final eligibility requirement, Project Developers must attest that project activities do not cause material violations of applicable laws (e.g. air, water quality, safety, etc.). To satisfy this requirement, Project Developers must submit a signed Attestation of Regulatory Compliance form[40] 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. Where a temporary or emergency restriction or regulation is in force during the reporting period, it shall be included in the assessment of the project's regulatory compliance.

A violation should be considered to be "caused" by project activities if it can be reasonably argued that the violation 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.

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

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 or reporting violations directly related to project activities may affect crediting, especially if related to negligence or intent on the part of the Project Developer or Grassland Owner. 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.

4 The GHG Assessment Boundary

The GHG Assessment Boundary delineates the GHG sources, sinks, and reservoirs (SSRs) that must be assessed in order to determine the net change in emissions caused by an avoided conversion of grasslands project.[41] The GHG Assessment Boundary encompasses all of the GHG SSRs that may be significantly affected by project activities, including biological CO_2 emissions and soil carbon sinks and sources of N_2O.

Figure 4.1 illustrates all relevant GHG SSRs associated with grassland project activities and delineates the GHG Assessment Boundary.

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. The SSRs which are marked with "(R)" represent those for which baseline emissions are reversible, and thus subject to the requirements for permanence in Section 3.5.

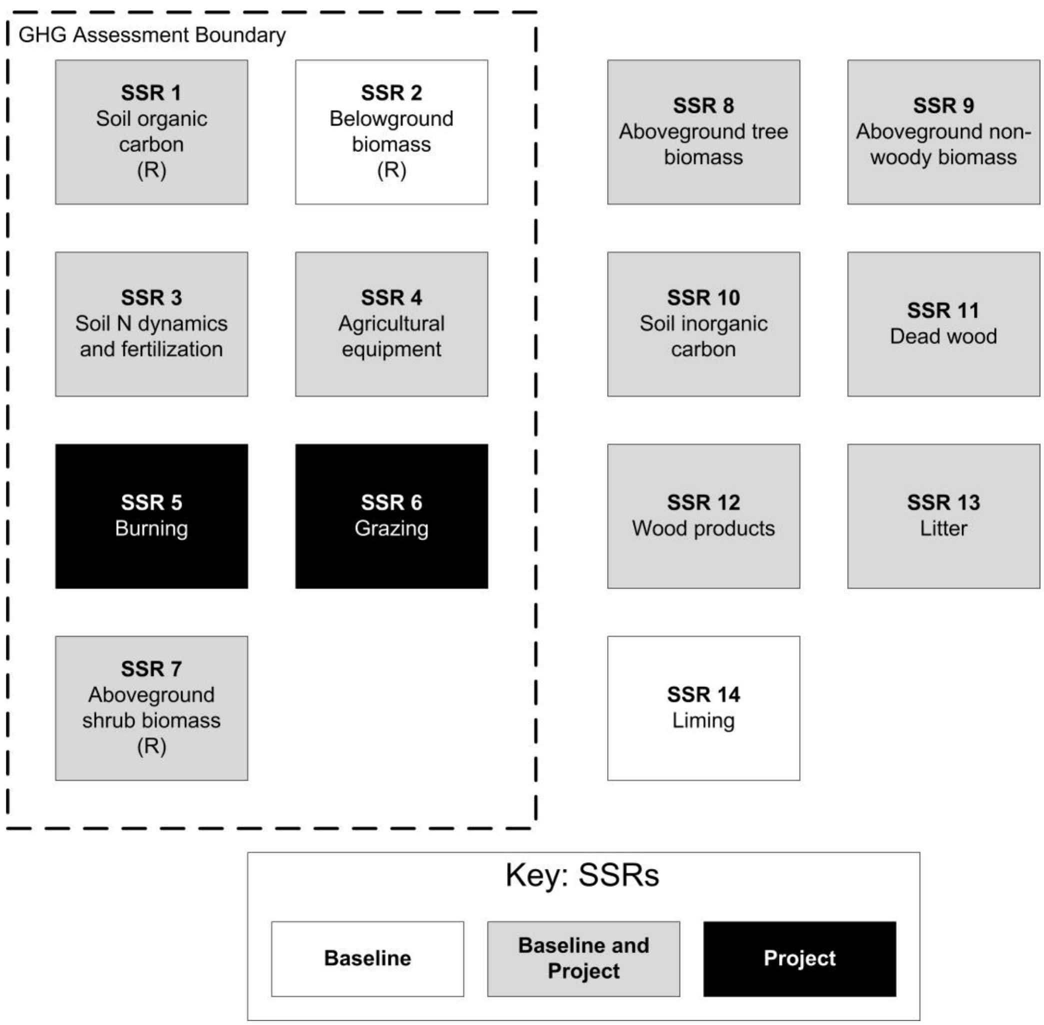

Figure 4.1. General Illustration of the GHG Assessment Boundary

[41] The definition and assessment of sources, sinks, and reservoirs is consistent with ISO 14064-2 guidance.

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

SSR	Source Description	Gas	Included (I), Optional (O), or Excluded (E)	Quantification Method	Justification/Explanation
1	Soil organic carbon	CO_2	I	Default emission factor modeled using DAYCENT	Emissions from the loss of soil organic carbon are a primary effect and major emission source in the baseline. Reversible.
2	Belowground biomass	CO_2	I	Default factor modeled using DAYCENT	Emissions from the loss of below-ground biomass are a primary effect and major emission source in the baseline. Reversible.
3	Soil nitrogen dynamics and fertilization	N_2O	I	**Baseline:** Default emission factors modeled using DAYCENT **Project:** Calculated based on monitored data	Direct and indirect N_2O emissions from conversion activities, soil processes and fertilization can be significant in the baseline. Direct and indirect N_2O emissions from fertilization can be significant in the project scenario, if applicable.
4	Agricultural equipment from site preparation and ongoing operations	CO_2	I*	**Baseline:** Default emission factor **Project:** Calculated based on monitored data	Fossil fuel emissions from equipment used for conversion site preparation and ongoing field operations (tillage, fertilization, etc.) may be significant in the baseline. * Excluded in jurisdictions where these emissions are subject to a binding cap (e.g. California). Emissions from equipment used for grassland management may be significant in the project scenario.
		CH_4	E	N/A	Excluded, as this emission source is assumed to be very small. The exclusion is conservative.
		N_2O	E	N/A	Excluded, as this emission source is assumed to be very small. The exclusion is conservative.
5	Burning	CO_2	E	N/A	CO_2 emissions due to grass biomass burning are considered biogenic and thus are excluded from the project boundary.

SSR	Source Description	Gas	Included (I), Optional (O), or Excluded (E)	Quantification Method	Justification/Explanation
		CH_4	I	Calculated based on monitored data	When grass biomass is burned, a portion of the carbon is released as CH_4. Depending on the area burned, this could be a significant source of project emissions.
		N_2O	I	Calculated based on monitored data	When grass biomass is burned, a portion of the carbon is released as N_2O. Depending on the area burned, this could be a significant source of project emissions.
6	Grazing	CO_2	E	N/A	Excluded, as this is not a significant source of emissions. Additionally, any CO_2 emissions from grazing would be considered biogenic.
		CH_4	I	Calculated based on monitored data	Grazing livestock in the project scenario produces potentially significant quantities of CH_4 through the decomposition of manure, as well as enteric fermentation.
		N_2O	I	Calculated based on monitored data	Grazing livestock in the project scenario produces potentially significant quantities of N_2O through the decomposition of manure.
7	Aboveground shrub biomass	CO_2	O	Field measurement and quantification	Emissions from the loss of above-ground shrub biomass can be a significant emission source in the baseline for certain projects. Exclusion would be conservative. Reversible.
8	Aboveground tree biomass	CO_2	E	N/A	Trees may hold a significant amount of biomass, but the fate of that carbon after conversion is uncertain, depending upon the volume of wood, the species, and the accessibility of mills. This protocol conservatively excludes tree biomass from the baseline emissions calculations.
9	Aboveground non-woody biomass	CO_2	E	N/A	Excluded, as the permanent pool is assumed to be very small, despite seasonal fluxes. The exclusion is conservative.

SSR	Source Description	Gas	Included (I), Optional (O), or Excluded (E)	Quantification Method	Justification/Explanation
10	Soil inorganic carbon	CO_2	E	N/A	Excluded, as this source is not included in the baseline modeling. The exclusion is conservative.
11	Dead wood	CO_2	E	N/A	Excluded, as this emission source is assumed to be very small. The exclusion is conservative.
12	Wood products	CO_2	E	N/A	Excluded, as this emission source is assumed to be very small. The exclusion is conservative.
13	Litter	CO_2	E	N/A	Excluded, as this emission source is assumed to be very small. The exclusion is conservative.
14	Liming	CO_2	E	N/A	Excluded, as the direction and magnitude of this emission source is uncertain. Current IPCC emission factors[42] treat liming as an emission source, whereas current USDA quantification methodologies[43] treat it as a net sink.

[42] IPCC (2006), 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4: Agriculture, Forestry and Other Land Use, Chapter 11: N_2O Emissions from Managed Soils and CO_2 Emissions from Lime and Urea Application. Available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_11_Ch11_N2O&CO2.pdf

[43] USDA (2014), Quantifying Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity-Scale Inventory. Available at: http://www.usda.gov/oce/climate_change/Quantifying_GHG/USDATB1939_07072014.pdf

5 Quantifying GHG Emission Reductions

GHG emission reductions from an avoided grassland conversion project are quantified by comparing actual project emissions to the calculated baseline emissions. Baseline emissions are an estimate of the GHG emissions from sources within the GHG Assessment Boundary (see Section 4) that would have occurred in the absence of the project. In the case of grassland projects, the baseline emissions include the loss of belowground organic carbon through conversion to cropland, as well as the GHG emissions from crop production. Project emissions are actual GHG emissions that occur at sources within the GHG Assessment Boundary. Project emissions include GHG emissions from grassland maintenance and grazing, as well as any leakage of baseline conversion activities. Project emissions must be subtracted from the baseline emissions to quantify the project's total net GHG emission reductions (Equation 5.1).

Quantification of baseline emissions is done through the use of default emission factors developed through a probabilistic composite modeling approach. This approach greatly simplifies the quantification and monitoring of grassland projects, as compared to an approach based on site-specific sampling and modeling. Additional discussion of this approach can be found in Appendix B.

Timelines for quantifying and reporting GHG emission reductions are detailed in Section 7.4. Project Developers may choose to quantify and verify GHG emission reductions on a more frequent basis if they desire. The length of time over which GHG emission reductions are periodically quantified is called the "reporting period." The length of time over which GHG emission reductions are verified is called the "verification period." Under this protocol, a verification period may cover multiple reporting periods (see Section 7.4).

As of this writing, the Reserve relies on values for global warming potential (GWP) of non-CO_2 GHGs published in the IPCC Second Assessment Report: Climate Change 1995.[44] The values relevant for this protocol are provided in Table 5.1, below. These values are to be used for all grassland projects unless and until the Reserve issues written guidance to the contrary. If these values are updated through issuance of future guidance, such a change will not be required to be adopted by projects which are Listed or Registered under this version of the protocol, but may apply to new projects submitted under this version of the protocol.

Table 5.1. 100-year Global Warming Potential for Non-CO_2 GHGs

Non-CO_2 GHG	100-Year GWP (CO_2e)
Methane (CH_4)	21
Nitrous Oxide (N_2O)	310

For project cooperatives, the quantification of emission reductions is carried out separately for each individual project. The cooperative structure does not change the quantification methodology contained within this section. To report the total results for the cooperative, the Cooperative Developer will simply sum the results of Equation 5.1 for each project in the cooperative. CRTs are serialized and issued to individual projects, rather than the cooperative.

[44] Available here: https://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml.

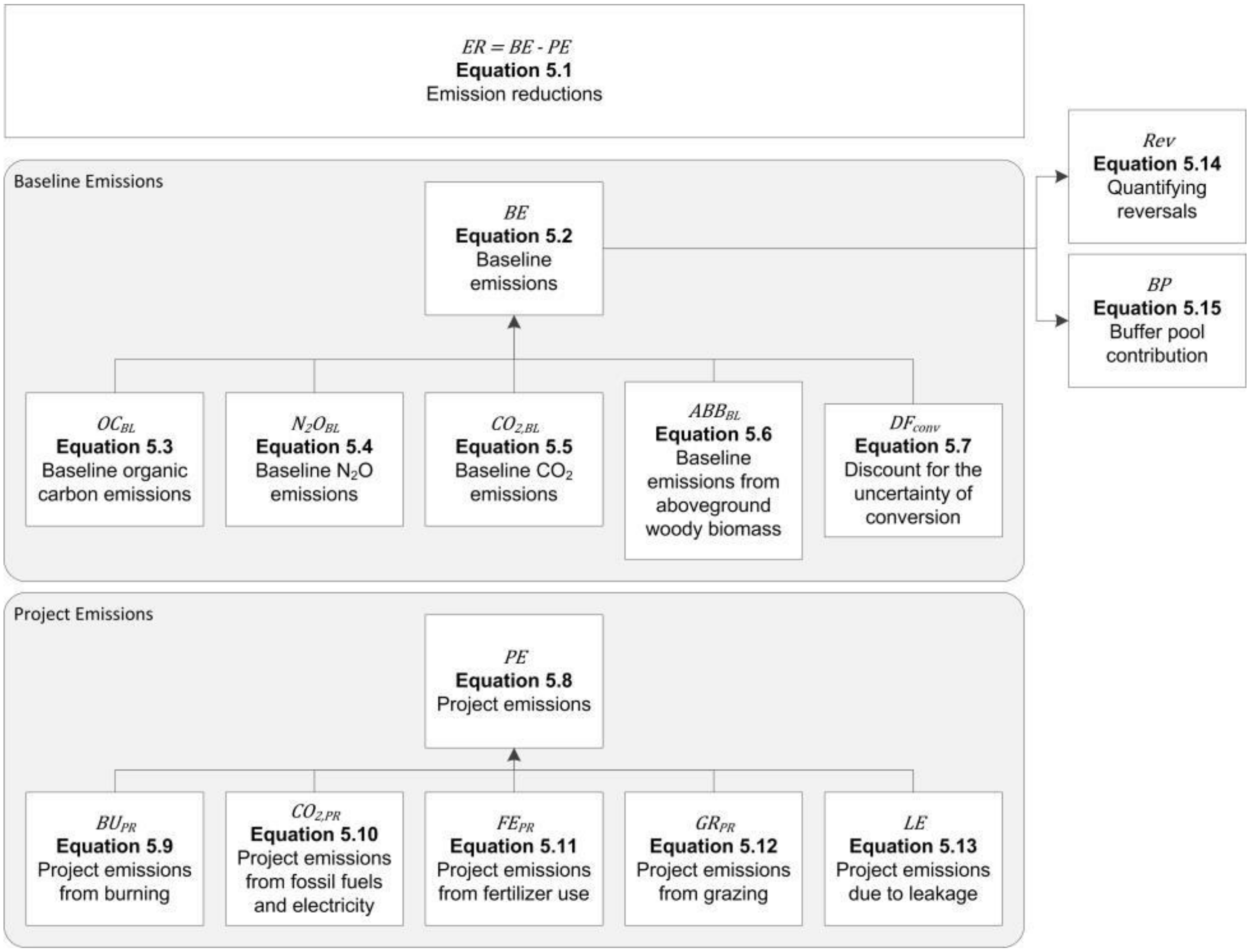

Figure 5.1. Organization of Quantification for Grassland Projects

Equation 5.1. GHG Emission Reductions

$$\boldsymbol{ER = BE - PE}$$

Where,

			Units
ER	=	Total emission reductions for the reporting period	tCO_2e
BE	=	Total baseline emissions for the reporting period, from all SSRs in the GHG Assessment Boundary (as calculated in 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 5.3)	tCO_2e

5.1 Stratification

For the purposes of this protocol, the U.S. has been stratified in order to enable the development of baseline and project emissions estimates that correspond to local soil conditions, climatic conditions, starting condition, and agricultural practices. A stratum represents a unique combination of these variables. All baseline and project modeling has been performed at the stratum level, enabling the resulting emissions estimates to represent relatively fine distinctions in the primary drivers of variation in emissions. In total, this protocol establishes emissions estimates for 1,002 total strata within the U.S. By stratifying the country in this manner, the emissions estimates used in this protocol provide greater local accuracy and representation than would emission estimates generated at a national scale or with fewer variables. These variables act as filters that bring greater specificity to the emissions estimates by more precisely estimating the conditions of the project. Land is first broken down by climate and geography, then further delineated by the major soil type and texture, and finally evaluated based on the previous land use.

For large projects, the project area may cover more than one stratum. In these instances, the project itself shall be divided up on an acreage basis into all appropriate strata. Instructions for identifying and calculating acreage in each stratum are provided in Section 5.1.4. All calculations shall be performed at the stratum level and summed to the project level where indicated.

The following variables are used to stratify the U.S., and shall be used to determine the appropriate stratum for a project or project area:

- Geography and associated climate
- Soil texture
- Previous land use

Each project shall be evaluated on the basis of each of these variables to determine its appropriate stratum, or strata, should its area contain multiple strata. The following sections provide guidance on determining the appropriate stratum for any parcel or portion of the project area.

5.1.1 Geography and Associated Climate

The first level of stratification used in this protocol delineates land based on its geography and associated climate, due to these factors' important influence over carbon pools and sources in both natural and managed ecosystems (Schimel, et al., 1994). Regional climate and geographic conditions are determined through the use of Major Land Resource Area (MLRA) designations, as defined by the U.S. Department of Agriculture, Natural Resources Conservation Services (USDA NRCS, 2006). These designations are used for a variety of policy and planning decisions, as they represent information about land suitability for farming and other purposes. As such, they constitute a land area that has similar physical and climatic characteristics. In total, there are approximately 280 MLRAs in the U.S. However, some of these MLRAs contain very little cropland or grassland feasible for conversion. Appendix B provides an overview of the methodology used to screen out certain MLRAs based on the absence of significant areas of grassland or cropland, and constraints on data availability and modeling confidence.

The USDA NRCS makes available tools for the geographic identification of MLRAs.[45]

5.1.2 Soil Texture

Soil texture has a significant impact on land productivity and carbon dynamics through influences on soil fertility and water balance and on soil organic matter stabilization processes (Six, Conant, Paul, & Paustian, 2002). Accordingly, the second level of stratification requires differentiating by soil texture. While successively finer delineations of soil type and texture would

[45] MLRA geographic data are available at: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053624.

yield greater precision, this protocol limits the stratification of soils into three major classes of surface soil texture as defined by USDA. These are:

- Sand (sand, loamy sand, sandy loam)
- Loam (loam, silt loam, silt)
- Clay (clay, clay loam, sandy clay loam, silty clay loam, sandy clay, silty clay)

5.1.3 Previous Land Use

Initial carbon pools at project commencement will be significantly influenced by previous land uses. Additionally, soil quality at project initiation influences nutrient inputs and farming practices in the baseline scenario. Because this protocol allows for the avoided conversion of grasslands with somewhat varied histories, the third level of stratification requires grasslands to be delimited by the duration of time it has been in a grassland state. This protocol defines the following two categories for grasslands:

- Greater than 10, but less than 30 years continuous grassland or pastureland
- Greater than 30 years continuous, long-term permanent grassland or pastureland

Per Section 3.1, all lands enrolled under this protocol must have been in a documented grassland or pastureland state for at least 10 years prior to project commencement. This requirement is necessary to ensure the validity of the baseline soil carbon emission factors. Areas that have exceeded 30 years of pre-project grassland cover are classified in a different stratum.

The Project Developer must document that the project site meets the definition of grassland as of the project start date. This may be done through a site visit by the project verifier, or through other sources of evidence. Table 5.2 contains examples of the two categories of evidence which may be employed to document land use of the project area for a given period of time. Category A evidence is independently sufficient for documenting land use for the relevant time period. Category B evidence may be used, but additional evidence (of either category) must be provided for the same period of time. For example, if a Project Developer can provide time-stamped aerial photos of the project area for every year of land use that must be documented, that will be considered sufficient. If a Project Developer provides satellite data indicating grassland as the land cover on the project area for a given year, at least one additional form of documentation (such as a contract or an affidavit) will be required for corroboration. Evidence cannot be corroborated by other evidence of the same type (e.g. satellite evidence cannot be corroborated by other satellite evidence). All land use evidence shall be subject to review and approval by the project verifier.

Table 5.2. Evidence Options for Land Use Justification

Category A: Evidence that is independently sufficient	Category B: Evidence that must be corroborated
▪ Site visit by the project verifier (applies only to the relevant reporting period) ▪ Time-referenced photos of the project area taken during the relevant year(s) (applies to the areas that can reasonably be assessed with these photos) ▪ Time-referenced aerial photos taken during the relevant year(s)	▪ Satellite data products, such as the Cropland Data Layer (CDL)[46], National Land Cover Database,[47] or MODIS Enhanced Vegetative Index[48] ▪ Contract(s) covering the relevant year(s) whose terms would require that the project area be grassland, but that would not cause the project to fail the Legal Requirement Test (e.g. grazing leases or haying contracts). ▪ Tax records that indicate the land use during the relevant year(s) ▪ Notarized affidavit(s) from unrelated and unaffiliated parties attesting to the land use in the relevant year(s) ▪ Notarized affidavit from the Grassland Owner(s) attesting to the land use in the relevant year(s) ▪ Other official records submitted to or generated by a government agency that would indicate the land use or management during the relevant year(s)

Table 5.2 is not meant to be comprehensive. The Project Developer may employ alternative approaches to monitoring land use on the project area, subject to review by the project verifier. The evidence provided to satisfy this requirement must be sufficient to provide reasonable assurance as to the nature of the land use during the relevant time period. Forms of evidence not listed under Category A shall be assumed to belong to Category B unless otherwise determined, in writing, by the Reserve.

5.1.4 Stratum Identification and Measurement

In total, this protocol stratifies the U.S. into 1,674 unique strata based on the three variables previously discussed (although emission factors were only able to be generated for 1,002 strata; see Appendix B for further details). Box 5.1 describes the method for naming each individual stratum. These names are then used in the companion tables for default parameters provided for each stratum.[49]

[46] The Cropland Data Layer is a free remote sensing product developed and provided by the USDA National Agricultural Statistics Service. The data are available online at: http://nassgeodata.gmu.edu/CropScape/.
[47] The NLCD is a free remote sensing product provided by the Multi-Resolution Land Characteristics Consortium. The data are released every 5 years and is available online at: http://www.mrlc.gov/.
[48] MODIS data are provided by NASA and the USGS. Information regarding MOD13Q1 (the 16-day 250m global vegetation indices) is online at: https://lpdaac.usgs.gov/products/modis_products_table/mod13q1.
[49] Certain parameters required for project eligibility and quantification are contained in a separate document, “Grassland Project Parameters,” available at: http://www.climateactionreserve.org/how/protocols/grassland/.

Box 5.1. Stratum Naming Convention

Name format: **X_Y_Z**

Where,		Range of Values
X =	Numbered designation of the MLRA in which the stratum is found	1 – 278
Y =	Soil texture classification	sand, loam, or clay
Z =	Minimum year threshold for the previous land use	10 or 30

EXAMPLES:

Stratum	MLRA	Soil Texture	Previous Land Use
1_Loam_10	1 - Northern Pacific Coast Range, Foothills, and Valleys	Loam	Greater than 10, but less than 30 years continuous grassland or pastureland
150A_Clay_30	150A - Gulf Coast Prairies	Clay	Greater than 30 years continuous, long-term permanent grassland or pastureland

Most quantification in this protocol is conducted at the stratum level. Equations require inputs in the form of total acreage within each stratum, and use of stratum-specific emission factors for various carbon pools and emissions sources. Project Developers must prepare a georeferenced map file that contains all project parcels, excluding any portion of the project parcel not legally permitted to be converted due to buffer restrictions[50] or other requirements. Each parcel shall be designated by its previous land use. If the parcel contains portions of more than one stratum, such that less than 95% of the parcel is in a single stratum, the map must indicate this boundary and these areas must be stratified separately.

Data from the Soil Survey Geographic Database (SSURGO) must be used to identify the acres of the parcel for each soil texture class. It is recommended that Project Developers utilize the NRCS Web Soil Survey (WSS) application,[51] which is a user-friendly tool for accessing data from SSURGO. If an alternate source of data from the SSURGO is available, use of the WSS as described here is not required. At a minimum, Project Developers must be able to identify the acreage of each soil texture group based on the dominant component[52] of each SSURGO map unit within the project area.

Through the WSS application, the user may locate the general area of the project parcel and then draw a detailed polygon around the project area. This identifies the Area of Interest (AOI) for which the data will be generated (it is preferable to use a previously-created shapefile to define the AOI, which ensures that the project boundaries are consistently defined). After

[50] For example, a landowner may be subject to regulations which limit how close crops may be grown to property boundaries or watercourses, or may require the maintenance of forested areas around watercourses or as windbreaks. In these cases, those restrictions would be represented by creating buffers around those features and excluding the buffered region from the project area.
[51] This web application is available at: http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx.
[52] Soil map units are comprised of multiple components, which are not represented on the map. In order to assign a single value to the map unit based on the values of the components, some aggregation method must be selected. This protocol applies the "dominant component" method, whereby the value of the component with the largest percent composition of the map unit is used to represent the value of the entire map unit.

identifying the correct AOI, select the “Soil Data Explorer” tab, then the “Soil Properties” subtab below it. Using the menu to the left, select “Soil Physical Properties” and then “Surface Texture.” Within the options for Surface Texture, select the Aggregation Method as “Dominant Component,” then click “View Rating.” This generates a table with the surface texture rating for each map unit within the AOI, identifying the acres for each. Then click “Printable Version” at the top right of the page to generate a PDF containing the AOI map and the table. This PDF aids with both stratification and verification. The texture ratings used in the soil data tables shall be aggregated into the three soil texture groups used in this protocol using the relationships described in Table 5.3.

Table 5.3. Soil Texture Categorization

SSURGO Texture Class	Grassland Protocol Texture Group
Sand	Sand
Loamy sand	Sand
Sandy loam	Sand
Loam	Loam
Silt loam	Loam
Sandy clay loam	Clay
Silty clay loam	Clay
Clay loam	Clay
Silty clay	Clay
Clay	Clay

5.2 Quantifying Baseline Emissions

Total baseline emissions for the reporting period are estimated by calculating and summing the emissions from all relevant baseline SSRs that are included in the GHG Assessment Boundary (as indicated in Table 4.1).

The baseline emission equations rely on emission factors which model the emissions of a full year. If this quantification methodology is being applied to a reporting period of less than one full year, Project Developers must refer to Box 5.2 in order to correctly pro-rate the annual baseline emission factors. Baseline emission factors for soil organic carbon, nitrous oxide, and fossil fuel emissions are organized in ten year groups. Those ten years are counted as calendar years from the year of the project start date, inclusive. The emission factor group to be used for a given reporting period is based on the beginning date of that reporting period, and applies throughout the reporting period. For example, if the project start date is May 9, 2015, the “Year 1-10” emission factor group shall be used for all reporting periods which begin during the years 2015-2024. For reporting periods beginning during 2025-2034, the “Year 11-20” emission factor group shall be applied.

Equation 5.2. Baseline Emissions

$$BE = \left[\left(OC_{BL} + N_2O_{BL} + CO_{2,BL}\right) \times (1 - DF_{\sigma}) + ABB_{BL}\right] \times (1 - DF_{conv}) \times Pro$$

Where,			Units
BE	=	Total baseline emissions for the reporting period, rounded down to the nearest whole number	tCO_2e
OC_{BL}	=	Baseline emissions due to loss of organic carbon in soil and biomass (Equation 5.3)	tCO_2e
N_2O_{BL}	=	Baseline emissions of nitrous oxide (Equation 5.4)	tCO_2e
$CO_{2,BL}$	=	Baseline CO_2 emissions due to fossil fuel combustion and electricity usage (Equation 5.5)	tCO_2e
ABB_{BL}	=	Baseline emissions due to the loss of above-ground shrub biomass (Equation 5.6) (optional)	tCO_2e
DF_{conv}	=	Discount factor for the uncertainty of baseline conversion (Equation 5.7)	%
DF_{σ}	=	Discount factor for the uncertainty of modeling future management practices and climatic conditions[53]	%
Pro	=	Pro-rating factor for reporting periods of less than one year (see Box 5.2)	%

Box 5.2. Pro-Rating for Reporting Periods of Less than One Year

Projects may report GHG reductions more frequently than on an annual basis. If a project reports on a sub-annual basis, then annual emission factors and quantities used in this section will need to be prorated. The following equation shall be used to determine the pro-rating factor for a sub-annual reporting period:

$$Pro = \frac{rd}{365.25}$$

Where,			Units
Pro	=	Pro-rating factor	%
rd	=	Number of reporting days in the sub-annual reporting period (i.e. days for which the project is claiming credit for emission reductions)	Days
365.25	=	Average number of days in a calendar year	Days

5.2.1 Baseline Organic Carbon Emissions

The baseline assumption for grassland projects is that the project area would be converted to cropland absent the project activities. When grassland is converted to cropland, carbon emissions occur through the loss of stored soil organic carbon over time. There is an immediate loss of soil carbon when the soil is tilled (Reicosky, 1998), followed by potentially decades of loss until a new equilibrium is reached. Determining the exact nature of the converted land use (crop rotation, tillage practices, fertilization, ongoing management) is complex, uncertain, and subjective. The Reserve has adopted a modeled, composite approach to determining organic carbon emissions from the baseline scenario for grassland projects. Refer to Appendix B for the

[53] Certain parameters required for project eligibility and quantification are contained in a separate document, "Grassland Project Parameters," available at: http://www.climateactionreserve.org/how/protocols/grassland/.

development of the emission factors used in this quantification and the companion tables for the baseline emission factors.

Equation 5.3. Baseline Organic Carbon Emissions from Soil and Belowground Biomass Loss

$$OC_{BL} = \sum_{S} \left(BEF_{OC,s} \times Area_s \div 1000\right)$$

Where,			Units
OC_{BL}	=	Baseline quantity of organic carbon emissions from soil and belowground biomass	tCO_2e
S	=	Total number of strata	
S	=	Individual stratum	
$BEF_{OC,s}$	=	Annual baseline emission factor for organic carbon in stratum *s* (refer to companion tables,[54] selecting the appropriate stratum and time category)	kg CO_2e/ac/yr
$Area_s$	=	Area of project in stratum *s*	acres
1000	=	Conversion factor	kg/t

5.2.2 Baseline N_2O Emissions

The use of fertilizer for crop cultivation results in emissions of nitrogen in the form of N_2O, which is a potent GHG.[55] Using emission factors developed with the composite modeling approach described in Appendix B, baseline emissions of N_2O are estimated for each stratum.

Equation 5.4. Baseline N_2O Emissions

$$N_2O_{BL} = \sum_{s}^{S} \left(BEF_{N_2O,s} \times Area_s \times GWP_{N_2O} \div 1000\right)$$

Where,			Units
N_2O_{BL}	=	Baseline emissions of N_2O	tCO_2e
$BEF_{N2O,s}$	=	Annual baseline emission factor for N_2O emissions in stratum *s* (refer to companion tables,[54] selecting the appropriate stratum and time category)	kg N_2O/ac/yr
$Area_s$	=	Area of the project in stratum *s*	acres
GWP_{N2O}	=	100-year global warming potential of N_2O (refer to Table 5.1).	CO_2e/N_2O
1000	=	Conversion factor	kg/t

5.2.3 Baseline CO_2 Emissions from Fossil Fuels

The conversion of grassland to cropland, as well as the ongoing cropland management activities, involves the use of fossil fuels for vehicles and equipment. This usage results in direct emissions of CO_2. Using emission factors developed with the composite modeling approach

[54] Certain parameters required for project eligibility and quantification are contained in a separate document, "Grassland Project Parameters," available at: http://www.climateactionreserve.org/how/protocols/grassland/.
[55] For additional details regarding the pathways of N_2O emissions due to fertilizer use, refer to the Reserve's Nitrogen Management Project Protocol, available online: http://www.climateactionreserve.org/how/protocols/nitrogen-management/.

described in Appendix B, baseline emissions of CO_2 are estimated for each stratum. If the project is located in a jurisdiction where GHG emissions from mobile sources are subject to a binding emissions cap (such as California[56]), then those projects may not claim emission reductions for this source, and must use a value of zero for $CO_{2,BL}$.

Equation 5.5. Baseline CO_2 Emissions from Fossil Fuel

$$CO_{2,BL} = \sum_{s}^{S} \left(BRC_{CO_2,s} \times \frac{10.15}{1000} \times Area_s \right)$$

Where, Units

$CO_{2,BL}$	=	Baseline emissions due to fossil fuel combustion	tCO_2e
$BRC_{CO2,s}$	=	Annual baseline rate of fossil fuel consumption for stratum *s* (refer to companion tables,[57] selecting the appropriate stratum and time category)	gal/ac/yr
10.15	=	Emission factor for diesel (distillate fuel #2)[58]	kg CO_2/gal
1000	=	Conversion factor	kg/t
Area	=	Area of project	acres

5.2.4 Baseline Emissions from Aboveground Shrub Biomass (Optional)

Some grassland areas may contain a significant quantity of woody biomass in the form of shrubs that would be lost in the conversion to cropland. Trees may hold a significant amount of biomass, but the fate of that carbon after conversion is uncertain, depending upon the volume of wood, the species, and the accessibility of mills. This protocol conservatively excludes tree biomass from the baseline emissions calculations, but does allow for the optional quantification of non-tree woody biomass (shrubs), which are likely to release their carbon relatively quickly following conversion. Definitions for “tree” and “shrub” are included in Section 9.

Equation 5.6. Baseline Emissions from Aboveground Shrub Biomass (Optional)

$$ABB_{BL,y} = ASB_{y=0} \times e^{(-0.77 \times (t-1))} - ASB_{y=0} \times e^{(-0.77 \times t)}$$

Where, Units

$ABB_{BL,y}$	=	Baseline emissions due to the loss of aboveground shrub biomass in the current project reporting year	tCO_2e
$ASB_{y=0}$	=	Aboveground shrub biomass at project initiation as determined below	tCO_2e
0.77	=	Decay rate, based on leaf decomposition in no-till cropland (Kochsiek, 2009)	yr^{-1}
t	=	Time since start date	years

[56] Additional information regarding the California cap-and-trade program is available at: http://www.arb.ca.gov/cc/capandtrade/capandtrade.htm.
[57] See the Reserve’s Grassland Project Protocol webpage at: http://www.climateactionreserve.org/how/protocols/grassland/
[58] 40 CFR Part 98 Subpart C Table C-1.

$$ASB_{y=0} = Area_{ASB} \times \sum_{SB} \left(\frac{DM_{sb}}{1000} \times CF_{sb} \times \frac{44}{12} \times Frac_{sb} \right)$$

Where, Units

SB	=	Total number of types of aboveground shrub biomass to be quantified	
sb	=	Individual type of aboveground shrub biomass	
DM_{sb}	=	Dry matter for aboveground shrub biomass type w*b* (additional guidance in Section 6.3)	kg/ac
1000	=	Conversion factor	kg/t
CF_{sb}	=	Carbon fraction of aboveground shrub biomass type w*b* (referenced from published data from either a government agency or a peer-reviewed article)	t C/t
$\frac{44}{12}$	=	Molar fraction of C in CO_2	CO_2/C
$Frac_{sb}$	=	Fraction of total aboveground shrub biomass area coverage represented by shrub biomass type w*b* (refer to Section 6.3)	%
$Area_{ASB}$	=	Area of aboveground shrub biomass canopy coverage	acres

5.2.5 Discount Factors

There are two discount factors that are applicable to the quantification of baseline emissions, DF_{conv} and DF_{σ}. DF_{conv} represents the uncertainty of using a standardized financial additionality threshold to represent the likelihood of the baseline conversion scenario. As the cropland premium decreases, uncertainty around the likelihood of baseline conversion increases. Equation 5.7 explains how to determine the value of this discount based on the value of the cropland premium for the county in which the project area is located (found in the companion tables[59]). In Equation 5.2, this discount is applied to the entire estimate of baseline emissions.

Equation 5.7. Discount Factor for the Uncertainty of Baseline Conversion

$$DF_{conv} = \left(1 - \frac{CP - FT_l}{FT_u - FT_l}\right) \times 50\%$$

Where, Units

DF_{conv}	=	Discount factor for the uncertainty of baseline conversion	%
CP	=	Cropland premium for the county where the project is located	%
FT_l	=	Lower threshold for financial additionality (Section 3.3.1.1)	%
FT_u	=	Upper threshold for financial additionality (Section 3.3.1.1)	%
50%	=	Maximum value of DF_{conv}	

DF_{σ} is meant to embody the uncertainty contained within the modeling of the baseline emission factors. The baseline emissions quantified in this protocol are discounted to account for increasing uncertainty about input assumptions and model outputs into the future. Uncertainty arises due to anticipated but unknown shifts in practices in, among other things, tillage, cropping, and nitrogen management, and the interaction of agricultural systems with a changing climate. Model inputs and outputs are expected to accurately reflect baseline conditions in early years, but will have less accuracy in future years. Accordingly, the quantification of baseline

[59] See the Reserve's Grassland Project Protocol webpage at: http://www.climateactionreserve.org/how/protocols/grassland/.

emissions is discounted , with the discount increasing through time in accordance with increasing uncertainty. The value of DF_{σ} for a given year is found in the separate file containing the companion tables.[60] If the modeling exercise is updated in the future, it is likely that this discount schedule would reset back to 1% for new projects that would use the updated emission factors. The discount factor is assigned based on the year of the beginning date of the reporting period (i.e. a reporting period which begins on May 9, 2019 would apply the discount listed for 2019 for an entire 12-month reporting period, even though a portion of the period will be in the calendar year 2020).

5.3 Quantifying Project Emissions

Project emissions are actual GHG emissions 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. In certain cases where these emissions are determined to be *de minimis*,[61] this protocol specifically allows for the Project Developer to use an alternative estimation methodology. Unless otherwise specified, project emission equations cover the entire reporting period, regardless of whether it covers a full year.

Equation 5.8. Project Emissions

$$PE = BU_{PR} + FF_{PR} + FE_{PR} + GR_{PR} + LE$$

Where,			Units
PE	=	Project emissions, rounded to the nearest whole number	tCO_2e
BU_{PR}	=	Emissions from burning in the project scenario (Equation 5.9)	tCO_2e
FF_{PR}	=	Emissions from fossil fuel and electricity use in the project scenario (Equation 5.10)	tCO_2e
FE_{PR}	=	Emissions from organic fertilizer use in the project scenario (Equation 5.11)	tCO_2e
GR_{PR}	=	Emissions from livestock grazing in the project scenario (Equation 5.12)	tCO_2e
LE	=	Leakage emissions (Equation 5.13)	tCO_2e

5.3.1 Project Emissions from Burning

The project scenario for a grassland project may involve periodic burning, either prescribed or accidental. Regardless of the reason for the fire, the combustion of aboveground biomass results in emissions of CO_2, CH_4, and N_2O. The CO_2 emissions from grass burning are considered biogenic and are excluded from this quantification. If credit was generated for avoided baseline emissions of shrub biomass, the CO_2 emissions from that material must be subtracted based on the area of shrub canopy which was burned (identified in the equation as "$Area_{burn,wb}$"), regardless of stratum. If recent aerial or satellite imagery are available to determine the canopy area which was burned, those resources shall be used. Otherwise, the area of shrub biomass canopy remaining on the project area shall be determined and used to estimate the area of shrub canopy which was burned. The project emissions of CH_4 and N_2O must be estimated using Equation 5.9.

[60] Certain parameters required for project eligibility and quantification are contained in a separate document, "Grassland Project Parameters," available at: http://www.climateactionreserve.org/how/protocols/grassland/.
[61] For the purposes of this protocol, emissions are *de minimis* if they are less than the relevant materiality threshold when applied to the overall calculation of emission reductions. The materiality threshold for projects is defined in the Verification Program Manual, available online at: http://www.climateactionreserve.org/how/verification/verification-program-manual/.

Equation 5.9. Project Emissions from Burning

$$BU_{PR} = \sum_{S} \left[\left(Area_{burn,s} \times \left(DM_s + DM_{sb,s} \right) \times \frac{2.3}{1000000} \times GWP_{CH_4} \right) + \left(Area_{burn,s} \times \left(DM_s + DM_{sb,s} \right) \times \frac{0.21}{1000000} \times GWP_{N_2O} \right) \right] + ABB_{BL,rp-} \times \frac{Area_{burn,sb}}{Area_{ASB}}$$

Where,			Units
BU_{PR}	=	Emissions from burning in the project scenario	tCO_2e
S	=	Total number of strata	
s	=	Individual stratum	
$Area_{burn,s}$	=	Area of stratum *s* that was burned	acres
DM_s	=	Amount of aboveground dry matter for shrub biomass in stratum *s* (refer to companion tables,[62] selecting the appropriate stratum and time category)	kg/acre
$DM_{sb,s}$	=	Dry matter for aboveground shrub biomass type w*b* in stratum *s* (additional guidance in Section 6.3)	kg/acre
2.3	=	Emission factor for methane from biomass burning[63]	g/kg dry matter
0.21	=	Emission factor for nitrous oxide from biomass burning[63]	g/kg dry matter
GWP_{CH4}	=	100-year global warming potential for methane (Table 5.1).	tCO_2e/tCH_4
GWP_{N2O}	=	100-year global warming potential for nitrous oxide (Table 5.1)	tCO_2e/tN_2O
1000000	=	Conversion factor	g/t
$ABB_{BL,rp-}$	=	Baseline emissions due to the loss of aboveground shrub biomass (total for all prior reporting periods)	tCO_2e
$Area_{burn,sb}$	=	Total area burned which contained monitored shrub biomass	acres
$Area_{ASB}$	=	Total area with monitored shrub biomass	acres

5.3.2 Project Emissions from Fossil Fuel and Electricity Use

In the case that the project activities include the use of mobile or stationary equipment or vehicles that consume fossil fuels or electricity, these project emissions are estimated using Equation 5.10. However, if the project can demonstrate that the total value of FF_{PR} is reasonably expected to be *de minimis* (i.e. less than the relevant materiality threshold[64]), these emissions may be estimated through a conservative method proposed by the Project Developer and deemed acceptable by the project verifier.

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[62] See the Reserve's Grassland Project Protocol webpage at: http://www.climateactionreserve.org/how/protocols/grassland/

[63] 2006 IPCC Guidelines for Greenhouse Gas Inventories, Chapter 2, Table 2.5.

[64] Materiality thresholds for Reserve projects are specified in the Reserve Verification Program Manual, available at: http://www.climateactionreserve.org/how/verification/verification-program-manual/.

Equation 5.10. Project Emissions from Fossil Fuels and Electricity

$$FF_{PR} = \frac{\sum_f \left(QF_f \times PEF_{FF,f}\right)}{1000} + \frac{(QE \times PEF_{EL})}{1000}$$

Where,

			Units
FF_{PR}	=	Carbon dioxide emissions due to fossil fuel combustion and electricity use in the project scenario	tCO_2e
QF_f	=	Quantity of fossil fuel type *f* consumed	volume
$PEF_{FF,f}$	=	Project emission factor for fossil fuel type *f* (Table C.1)	$kgCO_2$/volume fossil fuel
1000	=	Conversion factor	kg/t
QE	=	Quantity of electricity consumed during the reporting period	MWh
PEF_{EL}	=	Carbon emission factor for electricity used, referenced from the most recent U.S. EPA eGRID emission factor publication.[65] Projects shall use the annual total output emission rates for the subregion where the project is located (see Figure C.1)	kg CO_2/MWh

5.3.3 Project Emissions from Organic Fertilizer Use

Certain rangelands may see ecosystem improvements or possibly even enhanced carbon sequestration (not credited under this protocol) following the addition of organic soil amendments (Ryals & Silver, 2013). In the case that the project activities include the application of organic fertilizer (such as compost or manure), the project emissions of N_2O are estimated using Equation 5.11. This equation quantifies the total direct and indirect emissions of N_2O related to the application of organic fertilizers through the use of project-specific activity data and default emission factors. Additional information regarding the default emission factors used in the next two equations can be found in Appendix C.2. Accounting for leaching is required for counties where, on average, the annual precipitation exceeds 80% of annual potential evapotranspiration. This protocol assigns the leaching factor based on an analysis carried out for the annual U.S. GHG Inventory which identifies the probability of leaching on non-irrigated land for every county (US EPA, 2014). The results of this analysis are displayed in Figure 5.2 and are contained within the county-level companion tables.[66]

[65] Available online at: http://www.epa.gov/cleanenergy/energy-resources/egrid/
[66] Certain parameters required for project eligibility and quantification are contained in a separate document, "Grassland Project Parameters," available at: http://www.climateactionreserve.org/how/protocols/grassland/.

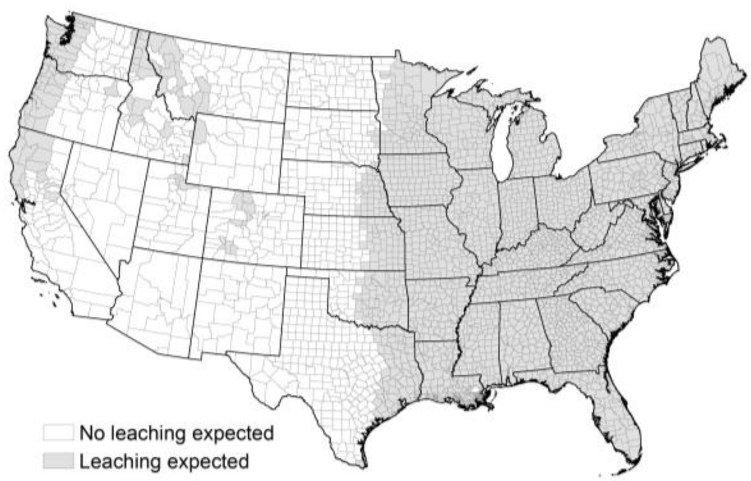

Figure 5.2. U.S. Counties Where Nitrogen Leaching is Expected to Occur

Equation 5.11. Project Emissions from Fertilizer Use

$$FE_{PR} = \left(\sum_{C} QF_{PR,c} \times NC_c\right) \times (0.012 + Leach) \times \frac{44}{28} \times GWP_{N_2O} \div 1000$$

Where,			Units
FE_{PR}	=	Direct and indirect nitrous oxide emissions from organic fertilizer use in the project scenario	tCO_2e
C	=	Total number of types of organic fertilizer applied, other than manure from grazing livestock	
$QF_{PR,c}$	=	Quantity of fertilizer type *c* applied	kg
NC_c	=	Nitrogen content of fertilizer type *c*	kg N/kg
0.012	=	Default factor representing the direct emission factor of N_2O from organic fertilizer, the fraction of N which is volatilized, and the indirect emission factor for N volatilization and deposition.	
Leach	=	Default factor for the fraction and emission factor for N_2O emissions due to leaching. Equal to **0.00225** for projects that are required to use this factor, and **0** for all other projects. Refer to the companion tables to determine whether leaching must be quantified for the county where the project is located.[54]	
$\frac{44}{28}$	=	Molar mass ratio of N_2O to N	kg N_2O/kg N_2O-N
GWP_{N2O}	=	100-year global warming potential for N_2O (Table 5.1)	tCO_2e/tN_2O
1000	=	Conversion factor	kg/t

5.3.4 Project Emissions from Grazing

It is likely that grasslands projects will employ livestock grazing on the project area in the project scenario, leading to enteric methane and manure (methane and nitrous oxide) emissions that would not exist in the baseline scenario. These emissions are quantified using Equation 5.12 and the guidance in Box 5.3. For the purposes of this equation, the "grazing season" is defined as the period of time between the first and last grazing days of the reporting period.

Equation 5.12. Project Emissions from Livestock Grazing

$$GR_{PR} = N_2O_{MN} + CH_{4,MN} + CH_{4,ENT}$$

Where,			Units
GR_{PR}	=	Project emissions from grazing activities in the project area	tCO_2e
N_2O_{MN}	=	N_2O emissions from manure deposited by grazing animals	tCO_2e
$CH_{4,MN}$	=	CH_4 emissions from manure deposited by grazing animals	tCO_2e
$CH_{4,ENT}$	=	CH_4 emissions from enteric fermentation in grazing animals	tCO_2e

$$N_2O_{MN} = \sum_L \left(AGD_l \times Nex_l \times (0.022 + Leach) \times \frac{44}{28} \times GWP_{N_2O} \div 1000\right)$$

Where,			Units
L	=	Total number of livestock categories in the project scenario	
AGD_l	=	Animal grazing days for livestock category *l* (see Box 5.3)	animal days
Nex_l	=	Nitrogen excreted by grazing animals in livestock category *l* (Table C.3)	kg N/head/day
0.22	=	Default factor representing the emission factor of nitrogen from manure, the fraction of N which is volatilized, and the emission factor for N volatilization. Additional details can be found in Appendix C.	
Leach	=	Default factor for the fraction and emission factor for N_2O emissions due to leaching. Equal to **0.00225** for projects which are required to use this factor, and **0** for all other projects. Refer to the companion tables to determine whether leaching must be quantified for the county where the project is located.[54]	
$\frac{44}{28}$	=	Molar mass ratio of N_2O to N	N_2O/N
GWP_{N2O}	=	100-year global warming potential for N_2O (Table 5.1)	CO_2e/N_2O
1000	=	Conversion factor	kg/t

$$CH_{4,MN} = \sum_L \left(AGD_l \times VS_l \times B_{0,l} \times MCF_{PRP} \times \rho_{CH_4} \times GWP_{CH_4} \div 1000\right)$$

Where,			Units
VS_l	=	Volatile solids excreted by grazing animals in category *l* (Table C.3)	kg VS/animal/day
$B_{0,l}$	=	Maximum methane potential for manure from category *l* (Table C.3)	m^3 CH_4/kg VS
MCF_{PRP}	=	Methane conversion factor for pasture/range/paddock manure management, dependent on average temperature during grazing season (Table C.2)	%
ρ_{CH4}	=	Density of methane at 1 atm and the average temperature during the grazing season (Table C.2)	kg/m^3
GWP_{CH4}	=	100-year global warming potential for CH_4 (Table 5.1)	CO_2e/CH_4

$$CH_{4,ENT} = \sum_L \left(AGD_l \times PEF_{ENT,l}\right) \times GWP_{CH_4} \div 1000$$

Where,			Units
$CH_{4,ENT}$	=	Enteric methane emissions from livestock grazing in the project scenario	tCO_2e
$PEF_{ENT,l}$	=	Project emission factor for enteric methane emissions from livestock category *l* in the project State (Table C.3)	kg CH_4/head/day

Box 5.3. Determining Animal Grazing Days (AGD_l)

Equation 5.12 requires the use of parameter AGD_l, which represents the total number of days that were grazed by a single category of animals. This is the sum of the number of days each animal category was grazed during the relevant time period. A simplified example is below:

Animal Category	Population	Grazing Months	Animal Grazing Days
Bulls	100	8	24,000
Beef Cows	200	8	48,000
Beef Replacements	40	8	9,600

Note: the numbers in this table are fictional used only for illustrative purposes

If the population of each category is not stable over the grazing period, a reasonable approach shall be applied to estimate AGD_l for each category over the relevant time period.

5.3.5 Project Emissions Due To Leakage

Avoided grassland conversion projects would result in leakage if the project activities result in the conversion of other grassland outside of the project area. This would cause the “avoided” baseline emissions to simply shift and occur elsewhere, thus never actually being avoided. The extent to which this occurs depends on the economics of crop production. The project emissions due to leakage represent the probability that the avoided baseline emissions will occur outside of the project area due to the project activities. Calculating a precise value for this probability is both complex and uncertain. As this protocol relies on default baseline assumptions which are composites of multiple baseline scenarios, it is not possible to determine a precise leakage value for each specific project.

Estimates of the leakage effects of grassland conservation are variable. Several studies have examined the Federal Conservation Reserve Program (CRP) to assess “slippage” (leakage) caused by conservation of arable land. One study determined the slippage effect of CRP enrollment to be 20% (i.e. for every 100 acres that are conserved, 20 acres are converted elsewhere) (Wu, 2000). A later study found no slippage effect from CRP enrollment (Roberts & Bucholtz, 2005). A third study determined that there is a range from 17.5% to 20.6%, depending upon the number of acres enrolled (higher enrollment led to higher slippage), as well as the elasticity of supply of nitrogen fertilizer (inelastic fertilizer supply led to higher slippage) (Taheripour, 2006). Lastly, another study, attempting to address the disagreement between the first two, used satellite imagery to attempt to estimate the magnitude of this effect, and came up with estimates that ranged from 3% to 11% (Fleming, 2010). This is all to say that estimates of leakage from CRP enrollment, a reasonable proxy for avoided grassland conversion, range from 0% to 20%, with evidence to support various values in the middle of that range. Thus, the Reserve has taken a conservative approach, assuming a 20% leakage effect from grassland projects.

Equation 5.13. Project Emissions from Leakage

$$\boldsymbol{LE = 0.2 \times BE}$$

Where,			<u>Units</u>
LE	=	Leakage emissions during the reporting period	tCO_2e
0.2	=	Leakage discount factor	
BE	=	Baseline emissions during the reporting period	tCO_2e

5.4 Ensuring Permanence of GHG Emission Reductions

If a reversal occurs during a reporting period (see Section 3.5), the reversal must be compensated for by retiring CRTs. Specific requirements depend on the whether the reversal was avoidable or unavoidable, as described below. Reversal compensation requirements do not apply to emission reductions unrelated to carbon stored in the project area soils (e.g. CH_4 and N_2O).

Identification of a reversal is a binary decision based on area; either an area is subject to a reversal or not. For example, if the Grassland Owner decides to plow and cultivate a 10 acre portion of the project area, that entire 10 acre portion shall be considered to have experienced a complete and avoidable reversal. If an area is subject to a reversal, then the quantity of soil carbon reversed is considered to be equal to total number of CRTs issued for reversible emission reductions on that specific portion of the project area. For the purposes of this protocol, reversible emission reductions are those related to the avoided loss of organic carbon in soil and belowground biomass (Equation 5.3) and the avoided loss of organic carbon in aboveground shrub biomass (Equation 5.6) for which CRTs were issued for reporting periods during the 100 years prior to the date of the reversal. The quantity of CRTs that must be retired is determined using Equation 5.14.

Equation 5.14. Quantifying Reversals

$$\boldsymbol{Rev} = \sum_{\boldsymbol{RP}} \left[\left[\boldsymbol{OC_{BL,rev,rp}} \times (\mathbf{1} - \boldsymbol{DF_{conv}}) + \boldsymbol{ABB_{BL,rev,rp}} \right] \times \left(\mathbf{1} - \boldsymbol{DF_{\rho,rp}} \right) \right]$$

Where, Units

Rev	=	Quantity of emissions due to the reversal	tCO_2e
RP	=	Total number of reporting periods for which CRTs have already been issued to the project	years
rp	=	Specific project reporting periods	
$OC_{BL,rev,rp}$	=	Baseline emissions due to the loss of organic carbon in soil and biomass in reporting period *rp* for the acres affected by the reversal (see below)	tCO_2e
DF_{conv}	=	Discount factor for the uncertainty of baseline conversion	
$ABB_{BL,rev,rp}$	=	Baseline emissions due to the loss of aboveground shrub biomass in reporting period *rp* for the acres affected by the reversal (summed for all reporting periods for which CRTs have been issued during the previous 100 years)[67]	tCO_2e
$DF_{\rho,rp}$	=	Discount factor for the uncertainty of modeling future management practices and climatic conditions for reporting period *rp*	

$$\boldsymbol{OC_{BL,rev,rp}} = \sum_{\boldsymbol{S,rp-n}}^{\boldsymbol{n=100}} \left(\boldsymbol{OC_{BL,s,rp-n}} \times \frac{\boldsymbol{Area_{rev,s}}}{\boldsymbol{Area_s}} \right)$$

Where, Units

$OC_{BL,s,y-n}$	=	Baseline emissions due to the loss of organic carbon and biomass in stratum *s* during reporting period *rp-n* (summed for all strata affected by the reversal and	tCO_2e

[67] For example, if the reversal occurs in year 125 of the project, only CRTs issued for years 25-50 shall be considered to have been reversed.

		all reporting periods for which CRTs have been issued during the previous 100 years)	
$Area_{rev,s}$	=	Area of stratum *s* affected by the reversal	acres
$Area_s$	=	Total project area in stratum *s*	acres

5.4.1 Avoidable Reversals

Requirements for avoidable reversals are as follows:

1. If an avoidable reversal is identified during annual monitoring, the Project Developer must give written notice to the Reserve within thirty days of identifying the reversal. Additionally, if the Reserve determines that an avoidable reversal has occurred, it shall deliver written notice to the Project Developer.
2. Within thirty days of receiving the avoidable reversal notice from the Reserve, the Project Developer must provide a written description and explanation of the reversal to the Reserve, including a map of the specific area which is affected.
3. Within four months of receiving the avoidable reversal notice, the Project Developer must transfer to the Reserve a quantity of CRTs from its Reserve account equal to the size of the reversal as calculated in Equation 5.14.
   a. The surrendered CRTs must be those that were issued to the grassland project, or that were issued to other grassland projects registered with the Reserve. If there is not a sufficient quantity of grassland CRTs available for compensation, as determined by the Reserve, CRTs issued to a forest project registered with the Reserve will be acceptable.
   b. The surrendered CRTs will then be retired by the Reserve and designated in the Reserve software as compensating for an avoidable reversal.

5.4.2 Compensating for Unavoidable Reversals

Requirements for unavoidable reversals are as follows:

1. If the Project Developer determines there has been an unavoidable reversal, it must notify the Reserve in writing of the unavoidable reversal within six months of its occurrence.
2. The Project Developer must explain the nature of the unavoidable reversal, including a map of the specific area affected, and provide an estimate of the size of the reversal using Equation 5.14.

If the Reserve determines that there has been an unavoidable reversal, it will retire a quantity of CRTs from the grassland risk buffer pool equal to the size of the reversal in CO_2-equivalent metric tons.

5.4.3 Contributing to the Risk Buffer Pool

For each reporting period, the Project Developer must transfer a quantity of credits (determined by Equation 5.15) to the Reserve Buffer Pool at the time of credit issuance. Credits that enter the buffer pool are never returned to the project directly (except as specified for credits related to $Risk_{SV}$), but instead are held in trust for the benefit of all grassland projects, to be used as compensation for unavoidable reversals, as described in Section 5.4.2. Equation 5.15 shall be used to calculate the buffer pool contribution for the project during the reporting period.

The risk of an unavoidable reversal to a grassland project is extremely low. Fires would not typically release the carbon that is stored underground. Catastrophic floods would typically only occur in areas that have already been screened out by the eligibility criteria. Volcanic activity is exceedingly rare in the conterminous U.S., and does not occur in the areas where grasslands projects will typically occur. Due to the fact that the risk of unavoidable reversals is not significantly differentiated by location or land management, the Reserve has decided to adopt a default buffer pool contribution for all projects that is intended to insure against all types of unavoidable reversals.

In addition to the default contribution, projects may be obligated to make additional contributions to the buffer pool in certain situations. Where the Project Developer has elected to employ a Contract PIA, an additional contribution is required to reflect risks from financial failure, and the value of $Risk_{FF}$ shall be 0.1. Where the Grassland Owner has elected to employ a Recorded PIA, and has elected to allow the PIA to be subordinated to subsequent deed restrictions (such as a mortgage), an additional contribution is required to reflect risks from financial failure. If the property owner has employed Recorded PIA Subordination Clause Type 1, the value of this risk is 0. If the property owner has employed Recorded PIA Subordination Clause Type 2, the value of this risk is 0.1.

Site visits during verification are not mandatory for grassland projects. However, there is risk associated with a project which has never been visited for the purposes of a third-party verification. The Reserve believes that this risk is low enough that the site visit during verification has been made optional. However, an additional buffer pool contribution must be made to account for the increased risk (designated as "$Risk_{SV}$" in Equation 5.15). For each project which has never had a site visit during verification, the value of $Risk_{SV}$ shall be 0.05 until such time that a site visit verification occurs.[68] At that time, the CRTs contributed to the buffer pool due to this requirement shall be returned to the project in the form of either a reduced buffer pool contribution in future reporting periods or a lump sum refund of CRTs from the buffer pool, subject to agreement between the Project Developer and the Reserve. The amount of CRTs to be returned shall be determined by calculating what the buffer pool contributions would have been had the value of $Risk_{SV}$ been 0 for the previous reporting periods. If a site visit occurs during the initial verification, the value of $Risk_{SV}$ shall be 0 for the entire crediting period. This applies equally to individual projects as well as projects participating in a cooperative. For example, if a cooperative contains 10 projects and site visits occur on only 2 of them during the initial verification, the remaining 8 projects will be subject to the increased buffer pool contribution, until such time that a site visit is carried out for those projects.

Equation 5.15. Buffer Pool Contribution to Insure Against Reversals

$$\boldsymbol{BP = Risk_{rev} \times (OC_{BL} + ABB_{BL})}$$

Where,

			Units
BP	=	Project contribution to the buffer pool	tCO_2e
$Risk_{rev}$	=	Risk of reversals, as determined below	%
OC_{BL}	=	Baseline quantity of organic carbon emissions from soil and biomass (Equation 5.3)	tCO_2e

[68] The reporting period during which the site visit occurs shall be the first reporting period not subject to the additional buffer pool contribution.

ABB_{BL}	=	Baseline emissions due to the loss of aboveground shrub biomass (Equation 5.6) (Optional – only include if Project Developer has chosen to quantify as part of baseline emissions)	tCO_2e

$$\boldsymbol{Risk_{rev} = 1 - [(1 - 0.02) \times (1 - Risk_{FF}) \times (1 - Risk_{SV})]}$$

Where,			<u>Units</u>
0.02	=	Default risk of unavoidable reversals, applicable to all projects[69]	fraction
$Risk_{FF}$	=	Additional risk related to financial failure. This shall be 0 for projects which employ a Recorded PIA with Subordination Clause Type 1, and 0.1 for projects which employ a Contract PIA or a Recorded PIA with Subordination Clause Type 2.[70]	fraction
$Risk_{SV}$	=	Risk of misstatement by projects which have not had a site visit by a third-party verifier. The value is either 0 or 0.1	fraction

As there are only three risk categories which contribute to $Risk_{rev}$, one of which is mandatory, there are only six possible project scenarios, leading to four possible values for this parameter. The potential project scenarios and the resulting value of $Risk_{rev}$ are listed in Table 5.4.

Table 5.4. Possible Values of $Risk_{rev}$

PIA	Site Visit	Default Risk	$Risk_{FF}$	$Risk_{SV}$	$Risk_{rev}$
Contract PIA	Yes	0.02	0.1	0	**0.118**
Contract PIA	No	0.02	0.1	0.05	**0.162**
Recorded PIA, Subordination Clause Type 1	Yes	0.02	0	0	**0.020**
Recorded PIA, Subordination Clause Type 1	No	0.02	0	0.05	**0.069**
Recorded PIA, Subordination Clause Type 2	Yes	0.02	0.1	0	**0.118**
Recorded PIA, Subordination Clause Type 2	No	0.02	0.1	0.05	**0.162**

[69] Based on discussion between and among Reserve staff and external stakeholders regarding the risks of unavoidable reversals to grassland projects. Such risks were determined to be low, but also not zero.
[70] The Project Implementation Agreements are available at: http://www.climateactionreserve.org/how/protocols/grassland/. Details on the buffer pool contribution related to subordination of the Recorded PIA are found in Exhibit E.

6 Project Monitoring

The Reserve requires a Monitoring Plan to be established for all monitoring and reporting activities associated with the project. The Monitoring Plan serves 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 a description of ownership of both the property and the emission reductions; the methods and frequency of data acquisition; a record keeping plan (see Section 7.3 for minimum record keeping requirements), and the role of individuals performing each specific monitoring activity. The Monitoring Plan should include QA/QC provisions to ensure that data acquisition and recordkeeping are carried out consistently and with precision.

Finally, 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 and the Regulatory Compliance Test (Section 3.3.2 and 3.6, respectively).

Project Developers are responsible for monitoring the performance of the project.

6.1 Monitoring Ongoing Eligibility

To maintain eligibility on an ongoing basis, grassland projects must demonstrate that the project area has not been converted into another land use during the reporting period. If the project verification includes a physical site visit, that will satisfy the requirements of this section. Otherwise, Project Developers shall refer to the guidance in Section 5.1.3 for guidance on documenting land use in the project area.

6.2 Monitoring Grazing

Livestock grazing is allowed in the project scenario. While low to moderate levels of grazing intensity may have a beneficial effect on the grassland ecosystem and net soil carbon storage (Derner, 2007), overgrazing can be detrimental to both the storage of soil carbon (Linghao, 1997) and the health of the grassland ecosystem (McGranahan, 2013). Project grazing must be limited to moderate levels of intensity, balancing stocking rates with forage production and accounting for site characteristics, including climate variability (especially periods of drought), range condition, slope, distance from water, and the needs of the particular animals (Holecheck, 1988) (Holechek, Gomes, Molinar, Galt, & Valdez, 2000). This is ensured through a combination of mechanisms:

1. Administrative mechanisms to prevent overgrazing, either:
    a. Prescribed grazing management plan; or,
    b. Legal limitations on grazing intensity; and
2. Monitoring of grazing intensity during the reporting period

CRTs will not be issued for any reporting period during which it is determined that there has been a violation of the administrative mechanism to prevent overgrazing.

6.2.1 Administrative Mechanisms to Prevent Overgrazing

Grassland projects must employ a mechanism to prevent overgrazing which is tailored to the specific conditions of their project and its ecosystem. This could be in the form of a prescribed grazing management plan or grazing limitations which are written into the conservation easement.

6.2.1.1 Prescribed Grazing Management Plan

If there are no legal limitations on grazing intensity (Section 6.2.1.2), the Project Developer must develop and implement a prescribed grazing management plan for livestock grazing on the project area during the reporting period. The plan should be developed following the principles of NRCS Conservation Practice Standard 528 for Prescribed Grazing, adhering to NRCS-recommended moderate stocking rates or lower.[71] The plan shall be reviewed and approved by either an agent of the NRCS or a professional with certification from either the Society for Range Management[72] or the American Forage and Grassland Council.[73] The management plan must specifically identify the protection of existing soil carbon pools as a management goal. Adherence to the plan shall be reviewed and confirmed by one of the entities listed above during the first reporting period and at least once every six years following the project start date. In years without a government or professional review of adherence to the prescribed grazing management plan, the verifier will take additional steps to assess the risk of nonconformance. This plan shall be updated to reflect any significant changes to the grazing management practices.

Per Section 3.3.3.2, it may be possible for the project to receive funding to implement a prescribed grazing management plan. A preexisting grazing management plan will not violate the Legal Requirement Test.

6.2.1.2 Legal Limitations on Grazing Intensity

If the project area is subject to legal limits on grazing intensity, with an explicit mechanism for ongoing monitoring and enforcement, the project is not required to develop and implement a prescribed grazing management plan. For example, an easement recorded on the project area may contain language specifically limiting livestock grazing to moderate intensity levels, with enough detailed stipulations for it to be effectively enforced. Overgrazing will be considered a violation of the terms of the easement, determined through ongoing monitoring, and subject to legal enforcement by the easement holder. The Reserve shall not seek to directly enforce the project easement, nor shall the verifier be expected to directly enforce the project easement. The verifier will merely consider the existence of ongoing monitoring and enforcement by the easement holder to represent a legal limit on grazing intensity. Project Developers are also encouraged to voluntarily implement a prescribed grazing management plan.

6.2.2 Monitoring of Grazing Activities during the Reporting Period

All grazing activities must be documented for the reporting period. For each reporting period, Project Developers must document the type of livestock being grazed and the total animal grazing days for each type(see Box 5.2). Although the unit for quantification is days, the grazing activities do not need to be monitored on a daily basis. Because grazing activities do not vary on a day-to-day basis, less frequent monitoring may be used to estimate the grazing days. The

[71] Available at: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_025729.pdf.
[72] www.rangelands.org
[73] www.afgc.org

livestock shall be categorized according to Table C.3. These data are used for the parameter AGD_l in Equation 5.12. The frequency of monitoring and the form of the documentation is not prescribed by this protocol. The verifier shall use professional judgment to confirm with reasonable assurance both that the quantification of project emissions from grazing is either accurate or conservative, and that grazing activities did not exceed limits on overgrazing, as specified by either Section 6.2.1 or Section 6.2.1.2.

Examples of potential grazing documentation (this list is not comprehensive nor is it intended to define sufficiency of documentation):

- Grazing logs (kept daily, weekly, or monthly) which specify the animal categories, populations, and grazing locations
- Animal purchase and sale records, assuming all animals are grazed on the project area
- Grazing management plan, assuming maximum allowable grazing activity

As an alternative, where the administrative mechanism employed to limit overgrazing (Section 6.2.1) can be reasonably and conservatively used to determine the animal category and maximum allowable population, then the project may conservatively assume that grazing activity was at the maximum. This alternative monitoring approach requires the Developer to provide some evidence to allow the verifier to be reasonably assured that the project did not exceed this assumed level. For example, this alternative could be employed by projects where some grazing documentation exists, but it is not sufficient to determine the AGD by animal category.

6.3 Monitoring Shrub Biomass

For projects that choose to quantify the emission reductions due to avoided loss of non-tree shrub biomass in the baseline scenario (Equation 5.6), this carbon pool must be monitored for the initial reporting period to quantify the emission reductions, as well as during each subsequent reporting period to ensure that there is not a reversal.

To determine the initial pool of shrub biomass, Project Developers must first use recent remote sensing data to estimate the canopy coverage (in ft^2) within the project area following the guidance in Section 2.3 of the Quantification Guidance for Urban Forest Management Projects (Climate Action Reserve, 2014). This area estimate will then be multiplied by a ratio of CO_2e per area ("carbon-to-canopy ratio") to get an estimate of CO_2e for the entire project area. The carbon-to-canopy ratio is determined by sampling on the ground following the general procedures described in Section 2.2 of the Quantification Guidance for Urban Forest Management Projects. However, as these plants may be less than breast height, which is the standard height for measuring tree diameter, the measurement guidance in this document shall be ignored. Project Developers shall use a source for estimating the aboveground biomass of individual plants from either a government agency publication or a peer-reviewed scientific publication. The total estimated biomass for each plot is then divided by the estimated canopy area for that plot to determine the carbon-to-canopy ratio.

6.4 Monitoring Project Emission Sources

For fossil fuels and electricity emissions (Equation 5.10), if the Project Developer can demonstrate that the total value of $CO_{2,PR}$ is reasonably expected to be *de minimis* (i.e. less than the relevant materiality threshold), these emissions may be estimated through a conservative method proposed by the Project Developer and deemed acceptable by the project verifier. If not required for the alternative method, the monitoring of fossil fuels and electricity as described in this section is not required.

Otherwise, for each reporting period, the Project Developer must provide documentation for the following parameters used for the quantification of project emissions:

- Total acres burned and cause(s) of fire(s)
- Animal grazing days by livestock category
- Mass of organic fertilizer applied (other than manure from grazing), by type
- Nitrogen content of organic fertilizer applied, by type
- Purpose, type, and quantity of fossil fuels used (e.g. tractor, diesel, 100 gallons)
- Purpose, source, and quantity of electricity used (e.g. electric fencing, MROW grid, 100 kWh)

For projects that employ additions of organic fertilizer (beyond the manure from on-site grazing of livestock), it is strongly encouraged that the project develop a nutrient management plan. Nutrient management plans should consider the principles contained in NRCS Conservation Practice Standard 590 for Nutrient Management.[74] Development of and adherence to a nutrient management plan is not required, but is strongly recommended.

6.5 Monitoring Project Cooperatives

There can be gains in efficiency through centralized monitoring for project cooperatives. A Cooperative Developer may organize their monitoring plan such that information from individual projects is collected and processed together. However, all information and documentation must be organized in such a manner that the verifier can assess that the requirements of this protocol have been met for each individual project. For example, it is acceptable to submit a single spreadsheet of grazing data for the cooperative, but the grazing data for each individual project must still be clearly defined within that spreadsheet.

6.6 Monitoring Parameters

Prescribed monitoring parameters necessary to calculate baseline and project emissions are provided in Table 6.1.

Table 6.1. Grassland Project Monitoring Parameters

Eq. #	Parameter	Description	Data Unit	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comment
General Project Parameters						
	Project Definition	Must confirm project land use has not changed		R, O	Each reporting period	Information used to asses that the project area remains as grassland
	Eligibility	Must satisfy all requirements of the Eligibility section		N/A	Each reporting period	Information used to assess satisfaction of the requirements of Section 3

[74] Available at: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046896.pdf.

Eq. #	Parameter	Description	Data Unit	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comment
	Regulations	Project Developer attestation of compliance with regulatory requirements relating to the project	Environmental regulations	N/A	Each reporting period	Information used to: 1) Demonstrate ability to meet the Legal Requirement Test – where regulation would prevent conversion of project area. 2) Demonstrate compliance with associated environmental rules, e.g. criteria pollutant limits.
Equation 5.3,Equation 5.4	S	Total number of strata relevant to the project area	strata	R	Once[75]	Information used to determine acres assigned to each relevant stratum.
Equation 5.1	ER	Emission reductions	tCO_2e	C	Per reporting period	Emission reductions are quantified once per reporting period per project. May be summed for reporting of a project cooperative
Equation 5.5	Area	Area of the entire project	acres	M	Once[75]	The project area is measured using GIS
Equation 5.3, Equation 5.4	$Area_s$	Area of project in stratum *s*	acres	M	Once[75]	The area of each stratum is measured using GIS
Baseline Calculation Parameters						
Equation 5.1, Equation 5.2,Equation 5.13	BE	Baseline emissions	tCO_2e	C	Per reporting period	Calculated based on default factors
Equation 5.2, Equation 5.3,Equation 5.15	OC_{BL}	Baseline emissions due to loss of organic carbon from soil and belowground biomass	tCO_2e	C	Per reporting period	Calculated for each stratum using default emission factors
Equation 5.2, Equation 5.4	N_2O_{BL}	Baseline emissions of nitrous oxide	tCO_2e	C	Per reporting period	Calculated for each stratum using default emission factors

[75] This parameter would only change if a portion of the project area was subsequently removed from the project and excluded from future quantification.

Eq. #	Parameter	Description	Data Unit	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comment
Equation 5.2,Equation 5.5	$CO_{2,BL}$	Baseline emissions of carbon dioxide	tCO_2e	C	Per reporting period	Calculated for each stratum using default consumption rates
Equation 5.2, Equation 5.6,Equation 5.15	ABB_{BL}	Baseline emissions due to loss of above-ground shrub biomass	tCO_2e	C	Per reporting period	Optional
Equation 5.2, Equation 5.7, Equation 5.14	DF_{conv}	Discount factor for the uncertainty of conversion	%	R	Once	The value of this uncertainty is based on the Performance Standard Test
Equation 5.2, Equation 5.14	DF_{σ}	Discount factor for the uncertainty of modeling future management practices and climatic conditions	%	R	Per reporting period	The value of this uncertainty is related to the amount of time that has passed since the baseline modeling was completed
Equation 5.2	Pro	Pro-rating factor	%	C	Per reporting period	For reporting periods which do not cover an entire year
Equation 5.3	CP	Cropland premium for the project site county	%	R	Once	The cropland premium for the project site county may be referenced from the companion tables[76]
Equation 5.3	$BEF_{OC,s,y}$	Annual baseline emission factor for organic carbon	kg CO_2e/ac/yr	R	Per reporting period	Default factor based on stratum
Equation 5.4	$BEF_{N2O,s}$	Annual baseline emission factor for N_2O emissions in stratum *s*	kg N_2O/ac/yr	R	Per reporting period	Default factor based on stratum
Equation 5.5	BRC_{CO2}	Annual baseline rate of consumption of diesel fuel due to cultivation activities	gal/ac/yr	R	Per reporting period	Default consumption rate based on stratum
Equation 5.5	EF_{FF}	Emission factor for diesel fuel	kg CO_2/gal	R	Per reporting period	Default value for all projects

[76] Certain parameters required for project eligibility and quantification are contained in a separate document, "Grassland Project Parameters," available at: http://www.climateactionreserve.org/how/protocols/grassland/.

Eq. #	Parameter	Description	Data Unit	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comment
Equation 5.6	$ASB_{y=0}$	Quantity of aboveground shrub biomass at project initiation	tCO_2e	C	Once	Optional. This quantity of biomass is assumed to decay following conversion
Equation 5.6	*t*	Time since start date	years	C	Per reporting period	Optional. The number of years counting from the start date, in whole numbers
Equation 5.6	SB	Types of aboveground biomass	N/A	M	Once	Optional. Species determines the amount of dry matter
Equation 5.6	DM_{sb}	Dry matter contained in biomass type w*b*	t/ac	R	Once	Optional. Referenced from literature based on species.
Equation 5.6	CF_{sb}	Carbon fraction of biomass type w*b*	t C/t biomass	R	Once	Optional. Referenced from literature based on species.
Equation 5.6	$Frac_b$	Fraction of total aboveground shrub biomass area coverage represented by biomass type *b*	%	M	Once	Optional. Determined through site inventory.
Equation 5.6	$Area_{ASB}$	Area of aboveground shrub biomass canopy coverage	acres	M	Once[75]	Optional. Estimated through remote sensing.
Project Calculation Parameters						
Equation 5.8	PE	Project emissions	tCO_2e	C	Per reporting period	Actual emissions in the project area during the reporting period.
Equation 5.8, Equation 5.9	BU_{PR}	Emissions from burning in the project scenario	tCO_2e	C	Per reporting period	Calculated only in the case of a fire during the reporting period.
Equation 5.8, Equation 5.10	FF_{PR}	Emissions from fossil fuels and electricity in the project scenario	tCO_2e	C	Per reporting period	Calculated only if fossil fuels or electricity are used for the project during the reporting period.
Equation 5.8, Equation 5.11	FE_{PR}	Emissions from fertilizer use in the project scenario	tCO_2e	C	Per reporting period	Calculated only if fertilizer is applied on the project area during the reporting period.

Eq. #	Parameter	Description	Data Unit	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comment
Equation 5.8, Equation 5.12	GR_{PR}	Emissions from livestock grazing in the project scenario	tCO_2e	C	Per reporting period	Calculated only if livestock grazing occurs on the project area during the reporting period.
Equation 5.8, Equation 5.13	LE	Emissions from leakage in the project scenario	tCO_2e	C	Per reporting period	Based on a default factor for leakage
Equation 5.9	$Area_{burn,s}$	Area of stratum *s* that was burned	acres	O	Per fire event	Estimated through either remote sensing or on-site measurement
Equation 5.9	DM_s	Amount of aboveground dry matter in stratum *s*	kg/ac	R	Per reporting period	Default factor based on stratum
Equation 5.9	$DM_{sb,s}$	Amount of aboveground dry matter in shrub biomass type *sb* in stratum *s*	kg/ac	R	Per fire event	Estimated only if baseline emissions were claimed for shrub biomass.
Equation 5.9	$ABB_{BL,rp-}$	Total baseline emissions due to loss of aboveground shrub biomass for all previous reporting periods	tCO_2e	O	Per fire event	Calculated only if baseline emissions were claimed for shrub biomass.
Equation 5.9	$Area_{burn,sb}$	The area that was burned which contained monitored shrub biomass	acres	O	Per fire event	Estimated only if baseline emissions were claimed for shrub biomass.
Equation 5.10	QF_f	Quantity of fossil fuel type *f* consumed	volume	O	Per reporting period	Includes fossil fuels consumed for any activities on the project area.
Equation 5.10	$PEF_{FF,f}$	Project emission factor for fossil fuel type *f*	kg CO_2/volume fuel	R	Per reporting period	Default emission factors provided
Equation 5.10	QE	Quantity of electricity consumed during the reporting period	MWh	O	Per reporting period	Includes any electricity consumed on the project area.

Eq. #	Parameter	Description	Data Unit	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comment
Equation 5.10	PEF_{EL}	Emission factor for electricity consumed	kg CO_2/MWh	R	Per reporting period	Referenced from the most recent U.S. EPA eGRID emission factor publication.[77] Projects shall use the annual total output emission rates for the subregion where the project is located
Equation 5.11	C	Total number of types of organic fertilizer applied, other than manure from grazing livestock	Categories	O	Per reporting period	Must be documented if fertilizer is applied on the project area during the reporting period.
Equation 5.11	QF_{PR}	Quantity of organic fertilizer type *c* applied	kg	O	Per reporting period	Must be documented if fertilizer is applied on the project area during the reporting period.
Equation 5.11	NC_c	Nitrogen content of fertilizer type *c*	kg N/kg fertilizer	O	Per reporting period	Must be documented if fertilizer is applied on the project area during the reporting period.
Equation 5.11, Equation 5.12	Leach	Default factor for the fraction and emission factor for N_2O emissions due to leaching	N/A	R	Once	Default factor based on the county where the project area is located.
Equation 5.12	N_2O_{MN}	N_2O emissions from livestock grazing	tCO_2e	C	Per reporting period	Based on AGD for each livestock category using default emission factors
Equation 5.12	$CH_{4,MN}$	CH_4 emissions from manure	tCO_2e	C	Per reporting period	Based on AGD for each livestock category using default emission factors
Equation 5.12	$CH_{4,ENT}$	CH_4 emissions from enteric fermentation	tCO_2e	C	Per reporting period	Based on AGD for each livestock category using default emission factors

[77] Available online at: http://www.epa.gov/cleanenergy/energy-resources/egrid/

Eq. #	Parameter	Description	Data Unit	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comment
Equation 5.12	L	Total number of livestock categories	Categories	O	Per reporting period	Documented for every reporting period where livestock are grazed on the project area.
Equation 5.12	AGD_l	Animal grazing days for livestock category *l*	Animal days	O	Per reporting period	Documented for every reporting period where livestock are grazed on the project area.
Equation 5.12	Nex_l	Nitrogen excreted by animals in livestock category *l*	kg N/animal grazing day	R	Per reporting period	Default factors based on livestock category and project state
Equation 5.12	VS_l	Volatile solids excreted by animals in livestock category *l*	kg VS/animal grazing day	R	Per reporting period	Default factors based on livestock category and project state
Equation 5.12	$B_{0,l}$	Maximum CH_4 potential for manure from animal category *l*	m^3 CH_4/kg VS	R	Per reporting period	Default factors based on livestock category
Equation 5.12	MCF_{PRP}	CH_4 conversion factor for pasture/range/pad dock manure management	%	R	Per reporting period	Default value based on average ambient temperature during the grazing season
Equation 5.12	ρ_{CH4}	Density of CH_4 at 1 atm pressure and the average ambient temperature during the grazing season	kg/m^3	R	Per reporting period	Based on average ambient temperature during the grazing season
Equation 5.12	$PEF_{ENT,l}$	Project emission factor for enteric methane emissions from livestock category *l*	kg CH_4/animal grazing day	R	Per reporting period	Default factors based on livestock category and project state

Eq. #	Parameter	Description	Data Unit	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comment
Equation 5.14	Rev	Quantity of emissions due to a reversal	tCO_2e	C	Per reversal event	Any event, avoidable or unavoidable, which causes a loss of belowground organic carbon or aboveground shrub biomass (if claimed in the baseline) results in a reversal of CRTs which have been issued. Reversals must be quantified and compensated for.
Equation 5.14	Y	Number of years for which CRTs have already been issued	years	O	Per reversal event	The magnitude of a reversal is related to the affected area and the number of CRTs which have already been issued.
Equation 5.14	$OC_{BL,rev,rp}$	Baseline emissions of organic carbon in soil and biomass in reporting period *y* for the acres affected by the reversal	tCO_2e	C	Per reversal event	The quantity of CRTs related to belowground organic carbon affected by the reversal
Equation 5.14	$ABB_{BL,rev,rp}$	Baseline emissions of organic carbon in aboveground shrub biomass in reporting period *rp* for the acres affected by the reversal	tCO_2e	C	Per reversal event	The quantity of CRTs related to aboveground shrub organic carbon affected by the reversal (if claimed in the baseline)
Equation 5.15	BP	Buffer pool contribution	tCO_2e	C	Per reporting period	Based on risk rating for the project
Equation 5.15	$Risk_{rev}$	Risk of unavoidable reversals	%	C	Per reporting period	Includes a default risk plus additional project-specific risks
Equation 5.15	$Risk_{FF}$	Risk related to financial failure	%	R	Once, unless the PIA is updated to change the subordination clause	The value is determined based on the specific subordination clause that is included in the PIA. Details can be found in Exhibit E of the PIA.

Eq. #	Parameter	Description	Data Unit	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comment
Equation 5.15	$Risk_{SV}$	Risk related to site visit schedule	%	R	Per reporting period	The value is determined based on whether the project or cooperative adheres to the recommended minimum site visit schedule.

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 across projects.

7.1 Time Periods for Reporting

Table 7.1 summarizes the various time periods that are relevant to AGC projects. Project Developers should recognize that recurring periods (such as reporting periods or verification periods) must always be contiguous, such that there are no gaps between recurring periods. CRTs can only be issued upon approval of a verification report by the Reserve.

Table 7.1. Guide to Relevant Time Periods for Grassland Projects

Description	Time Period	Protocol Section
Project lifetime	Up to 150 years	2.2
Conservation easement term	Perpetual	2.2
Pre-project land use history	No less than 10 years prior to project start date	2.2
Crediting period	No more than 50 years following project start date	3.4
Reporting period (first)	No more than 24 months	7.4
Reporting period (subsequent)	No more than 12 months	7.4
Verification period (first)	First reporting period	7.4
Verification period (subsequent)	No more than 6 reporting periods	7.4
Permanence period	100 years following crediting period	3.5
Monitoring period (easement enforcement)	No more than 6 years	7.5.1
Monitoring period (outside of easement enforcement)	No more than 3 years	7.5.2
Verification period (outside of easement enforcement)	No more than 15 years	7.5.2

7.2 Project Documentation

Project Developers must provide the following documentation to the Reserve in order to register a grassland project:

- Project Submittal form (or Cooperative Submittal form)*
- Property ownership documentation*
- Project conservation easement
- Project Implementation Agreement
- Project area map (this map is public; it is only required to show the outer extent of the project area and is not required to be in a georeferenced format)*
- Signed Attestation of Title form
- Signed Attestation of Voluntary Implementation form
- Signed Attestation of Regulatory Compliance form
- Verification Report
- Verification Statement

** Denotes items that are required at the time of project submittal.*

Project Developers must provide the following documentation for each verification period during the crediting period in order for the Reserve to issue CRTs for quantified GHG reductions:

- Verification Report
- Verification Statement
- Signed Attestation of Title form
- Signed Attestation of Voluntary Implementation form
- Signed Attestation of Regulatory Compliance form
- Georeferenced project boundary map (this map is private; it must delineate the actual polygons of the eligible project area, and must be a shapefile or KML format)

Project Developers must provide the following documentation for each verification period during the permanence period in order for the project to remain active and not subject to termination:

- Verification Report
- Verification Statement
- Signed Attestation of Title form
- Georeferenced project boundary map (this map is private; it must delineate the actual polygons of the eligible project area, and must be a shapefile or KML format)

At a minimum, the above project documentation (except as noted) is 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/.

7.3 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 is not publicly available, but may be requested by the verifier or the Reserve.

System information the Project Developer shall retain includes:

- Detailed, georeferenced project maps (created per guidance in Section 2.2.1)
- Ongoing monitoring reports or documentation related to the conservation easement
- All data inputs for the calculation of the project emission reductions, including all required sampled data
- Annual overlay of the project area boundary on the CDL and additional form of documentation of the continued conservation of the grassland cover in the project area (see Section 6.1)
- 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
- Executed Attestation of Title, Attestation of Regulatory Compliance, and Attestation of Voluntary Implementation forms
- Onsite fossil fuel use records, if applicable
- Onsite grid electricity use records, if applicable
- Grazing management plan, if applicable
- Nutrient management plan, if applicable
- Grazing management records

- Fertilizer use records, if applicable
- Documentation of fires, if applicable
- Results of annual CO_2e reduction calculations
- Initial and annual verification records and results

7.4 Reporting Period and Verification Cycle

The reporting period is the length of time over which GHG emission reductions from project activities are quantified. Project Developers must report GHG reductions resulting from project activities during each reporting period. A reporting period may not exceed 12 months in length, except for the initial reporting period, which may cover up to 24 months. The Reserve will accept verified emission reduction reports on a sub-annual basis, should the Project Developer choose to have a sub-annual reporting period and verification schedule (e.g. monthly, quarterly, or semi-annually). However, it is recommended that projects follow a calendar year reporting schedule to simplify the application of the quantification and monitoring requirements. Reporting periods must be contiguous; there must be no gaps in reporting during the crediting period of a project once the first reporting period has commenced.

The verification period is the length of time over which GHG emission reductions from project activities are verified. The initial verification period for a grassland project is limited to one reporting period. Subsequent verification periods may cover up to six reporting periods. It is required that a project verification occur at least every six years during a project's crediting period. CRTs will not be issued for reporting periods that have not been verified. Project Developers may choose to verify more frequently than every six reporting periods. For any reporting period which ends prior to the end of the verification period (i.e. years 1-5 of a 6 year verification period), an interim monitoring report must be submitted to the Reserve no later than 90 days following the end of the relevant reporting period. The interim monitoring report shall contain a summary of ownership, evidence of land use, and basic documentation of project emissions during the relevant reporting period.[78] See Section 7.5 for guidance on reporting and verification activities after the crediting period is concluded.

To meet the verification deadline, the Project Developer must have the required verification documentation (see Section 7.2) submitted within 12 months of the end of the verification period. The end date of any verification period must correspond to the end date of a reporting period. No more than six reporting periods (a maximum of 72 months) can be verified at once during the project's crediting period.

7.5 Reporting and Verification of Permanence

When the crediting period for a Grassland project ends, the project enters the permanence period. Per Section 3.5, the project area must be monitored to ensure against reversals for a period of 100 years following the last issuance of CRTs related to carbon pools at the project site (i.e. soil organic carbon and aboveground shrub biomass, if claimed). During the permanence period, no emission reductions are claimed and no new credits are issued. Projects may elect to begin the permanence period prior to the end of their maximum allowable crediting period by notifying the Reserve in writing prior to their next reporting deadline. This monitoring can take different forms depending on the terms of the conservation easement which binds the project area. In any case, monitoring must continue through the permanence period to confirm that no reversals have occurred, and the results of this monitoring must be reported to

[78] A template monitoring report will be available at: http://www.climateactionreserve.org/how/program/documents/.

the Reserve periodically. There are two categories of monitoring scenarios: projects may either be monitored as part of their easement monitoring activities, or they may be monitored specifically for the carbon project. In both cases, the required periodic monitoring reports shall, at a minimum, contain the following:

- Evidence to support the conclusion that no reversals have occurred on the project area since the previous reported time period
- Information related to ongoing activities on the site, including grazing
- Updated information related to ownership of the property, the easement, and the rights to the soil carbon

These reports are not required to be verified, but must be reviewed and approved by the Reserve in order for the terms of the PIA to be satisfied. Project emissions are not quantified during the permanence period. If a reversal is identified, it must be reported to the Reserve and the guidance in Section 5.4 regarding compensation for reversals shall apply.

7.5.1 Monitoring through Easement Activities

If a project area is subject to the terms of a Qualified Conservation Easement (Section 3.5.1) which includes provisions for ongoing monitoring and specific mechanisms for enforcement, such monitoring activities may be considered sufficient for the purposes of this protocol. The Project Developer must submit a monitoring report at least every six years (i.e. this report will be due no later than 72 months after the end date of the previous verification or monitoring period, whichever is relevant). The Reserve maintains the right to determine whether the terms of a conservation easement are sufficient to meet the requirements of this section. An easement may be amended at any time to meet these requirements, subject to approval by the Reserve. If the monitoring is not carried out according to the terms of the easement or the monitoring reports are not received by the Reserve, the Project Developer may be in breach of the PIA.

7.5.2 Monitoring for Carbon Separately

If the conservation easement does not contain monitoring and enforcement terms which satisfy Section 7.5.1, the Project Developer must continue monitoring and reporting activities through other means. Projects must prepare and submit a monitoring report to the Reserve at least every 3 years (i.e. this report will be due no later than 36 months after the end date of the previous verification or monitoring period, whichever is relevant). These monitoring reports shall be verified at least every fifteen years, although verification may be more frequent. The verification deadlines described in Section 7.4 shall apply.

7.6 Joint Reporting of Project Cooperatives

Project cooperatives carry out a certain amount of joint effort for reporting. While the quantification section shall be applied to each project independently, the results may be collected and reported together to the Reserve by the Cooperative Developer. Reports and documentation may be combined for efficiency, but it must be possible to trace the evidence for the emission reductions from each individual project.

In the management of a cooperative, certain documents are required to be submitted for each individual project, while certain other documents may be submitted once for the entire cooperative. Table 7.2 details which documents belong to which category. Documents required to be submitted for each individual project may be combined into a single digital file (for example, all attestations for projects within the cooperative may be combined into a single PDF). The Cooperative Developer will submit all documentation through their Reserve account, into the document repository for the cooperative. Once the verification report is registered, CRTs shall be issued to the Project Developer account associated with each project in the cooperative.

Table 7.2. Document Management for Project Cooperatives

May Apply to the Cooperative	Must be Submitted for Each Individual Project[79]
▪ Cooperative Submittal form ▪ Attestation of Regulatory Compliance form ▪ Verification Report ▪ Verification Statement	▪ Property ownership documentation ▪ Attestation of Title form ▪ Attestation of Voluntary Implementation form ▪ Project maps

7.6.1 Cooperative Verification Cycle

The verification period for the entire cooperative must end on the same date, unless a project reaches the end of its crediting period during the verification period. In that case, it is acceptable for that project to end reporting prior to the end of the cooperative's verification period. However, during a project's first verification as a member of a cooperative it may begin reporting at a date that is different from other projects in the cooperative. It is likely that each project in a cooperative will have a different start date, and thus during the initial verification for a cooperative each project will begin reporting on a different date. The initial verification period will cover a single reporting period, and the initial reporting period may be up to 24 months in length. Although the individual projects will begin their reporting periods on different dates, they shall all end on the same date, such that subsequent verifications of the cooperative will cover the same length of time for every project. When a project joins a cooperative which has already undergone verification, that project's next reporting period must not begin prior to the end of the cooperative's previous verification period, but it may begin at a date that is later than the beginning of the cooperative's next reporting period. Table 7.3 describes various cooperative scenarios and the resultant outcomes for their respective verification cycles.

If an individual project within a cooperative is unable to meet the requirements of this protocol for one or more reporting periods, they may report zero credits for that time period and continue to be verified as part of the cooperative. For reporting periods where a project claims zero credits, the verifier shall confirm that project emissions were not greater than baseline emissions, and that no reversals occurred. Additional guidance regarding Zero Crediting Reporting Periods can be found in the Reserve's Program Manual.[80]

Table 7.3. Example Cooperative Verification Scenarios

Example Scenario	Resulting Verification Cycle
1. Cooperative X contains two projects: Project A has a start date of 1/1/15 and Project B has a start date of 7/22/15.	The initial verification period for the cooperative would cover 1/1/15 – 12/31/16. Project A would report for the entire period, while Project B would report only for 7/22/15 – 12/31/16.
2. Project C wishes to join Cooperative X. Project C has a start date of 5/9/17.	The next reporting period for the cooperative will be 1/1/17 – 12/31/17. The first reporting period for Project C would be 5/9/17 – 12/31/17.

[79] These documents for individual projects may be electronically combined into a single PDF (e.g. one digital file may contain the individual Attestation of Title forms for every project in the cooperative).
[80] Available at: http://www.climateactionreserve.org/how/program/program-manual/.

3. Project D wishes to join Cooperative X. Project D has a start date of 1/1/16 and has not yet gone through verification.	There are two options: *Option i*: The project may undergo verification as a standalone project for the period 1/1/16 – 12/31/16, then subsequently join the cooperative for future reporting. *Option ii*: The project may join the cooperative immediately, taking a Zero Credit Reporting Period for 1/1/16 – 12/31/16, and begin reporting on 1/1/17 with the cooperative's next verification period.
4. Project E wishes to transfer into Cooperative X from another, different cooperative, which has already undergone verification. The last verification period for Project E ended on 6/30/16.	There are two options: *Option i*: The project may undergo verification as a standalone project for the period 7/1/16 – 12/31/16, then subsequently join the cooperative for future reporting. *Option ii*: The project may join the cooperative immediately, taking a Zero Credit Reporting Period for 7/1/16 – 12/31/16, and begin reporting on 1/1/17 with the cooperative's next verification period.

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 grassland projects.

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

- Climate Action Reserve Program Manual
- Climate Action Reserve Verification Program Manual
- Climate Action Reserve Grassland Project Protocol

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

Only ANSI-accredited verification bodies trained by the Reserve for this project type are eligible to verify grassland project reports. Verification bodies approved under other project protocol types are not permitted to verify grassland projects.[81]

8.1 Joint Verification of Project Cooperatives

Projects that participate in a project cooperative are verified together for every verification period. The Cooperative Developer has their own account on the Reserve through which they submit all documentation related to the cooperative. One set of verification documentation shall be submitted for the entire cooperative, but the project-specific attestations must be executed by the Project Developer for each project.

If the verifier cannot reach a positive verification opinion for one or more projects within a cooperative, the verification may still be completed, and emission reductions registered for the projects for which the verifier can reach a positive opinion. However, the verification of the cooperative as a whole cannot be approved by the Reserve unless an opinion is rendered on every project within the cooperative.

8.2 Standard of Verification

The Reserve's standard of verification for grassland projects is the Grassland Project Protocol (this document), the Reserve Program Manual, and the Verification Program Manual. To verify a grassland 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.

[81] Information about verification body accreditation and Reserve project verification training can be found on the Reserve website at http://www.climateactionreserve.org/how/verification/.

8.3 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 are 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.

8.4 Verifying Project Eligibility

Verification bodies must affirm a grassland project's eligibility according to the rules described in this protocol. The table below outlines the eligibility criteria for grassland 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 Grassland Project

Eligibility Rule	Eligibility Criteria	Frequency of Rule Application
Start Date	Until July 22, 2016, a pre-existing project with a start date on or after July 22, 2013 may be submitted for listing; after this deadline, projects must be submitted for listing no more than 6 months after the project start date	Once during first verification
Start Date	Recordation of a conservation easement, transfer of the project area to Federal Government ownership, or execution of a notarized contract as allowed in Section 3.2.1	Once during first verification
Location	Conterminous United States and tribal areas	Once during first verification
Location	Project strata must have a positive baseline emission factor for soil organic carbon during the reporting period	Every verification
Performance Standard	Project county must pass the financial threshold at the time of project submittal	Once during first verification
Performance Standard	Project area must pass the suitability threshold	Once during first 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
Credit and Payment Stacking	Projects must meet credit and payment stacking requirements and disclose all credits or payments received in relation to the project area	Every verification
Regulatory Compliance Test	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
Project Implementation Agreement	The Project Developer must execute a PIA with the Reserve prior to the initial registration	Once during first verification

8.5 Core Verification Activities

The Grassland Project Protocol provides explicit requirements and guidance for quantifying the GHG reductions associated with the avoided conversion of grasslands to croplands. 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 grassland 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 GHG management systems and estimation methodologies
3. Verifying emission reduction 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 grassland Project Developer uses to gather data and calculate baseline and project emissions, based on the guidance in Sections 5 and 6.

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 may involve site visits to the project area (or areas if verifying a project cooperative) to ensure the activities 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 GHG emission reductions.

8.5.1 Site Visits

Site visits during verification are strongly recommended, but are not mandatory for grassland projects. However, there is risk associated with a project that has never been visited for the purposes of a third-party verification. This risk is related to the lack of direct, physical inspection of the project area and personal, face-to-face interaction with the project participants, which are valuable components of typical offset project verification activities. The Reserve believes that this risk is low enough in the case of grassland projects that the site visit during verification has been made optional. However, an additional buffer pool contribution must be made to account for the increased risk for those projects which forego a site visit verification. Section 5.4.3 details how this contribution is determined. Although the site visit is optional, it may be carried out at the discretion of the Project Developer or the verifier.

When a site visit is carried out for the verification of a grassland project, the site visit may occur during the verification period or after its conclusion. During this visit the verifier will confirm the eligibility of the existing land use, assess the accuracy of the project maps, assess the sources of project emissions, and assess the management and recordkeeping related to the project.

8.5.2 Desk Review Verification

For verifications which do not include a site visit, the verification body must follow the same standards and procedures, but is not required to physically visit the project site. Desk review verifications must achieve the same standard of reasonable assurance.

8.6 Grassland Verification Items

The following tables provide lists of items that a verification body needs to address while verifying a grassland project. The tables include references to the section in the protocol where requirements are further specified. The table also identifies 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 grassland projects that must be addressed during verification.

8.6.1 Project Eligibility and CRT Issuance

Table 8.2 lists the criteria for reasonable assurance with respect to eligibility and CRT issuance for grassland 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 grassland project	No
2.2.1	Verify that the project area has been correctly delineated on a map (or maps) that meets the requirements of the protocol	No
2.3	Verify ownership of the GHG reductions by reviewing Attestation of Title and accompanying documentation	No
2.3	Verify the project and/or cooperative structure is appropriate	No
3.2	Verify project start date	No
3.2	Verify accuracy of project start date based on documentation	Yes
3.2	Verify that the project has documented and implemented a Monitoring Plan	No
3.3, 3.4	Verify that the entire reporting period is within the crediting period for the project	No
3.3.1	Verify that the project meets the Performance Standard Test	No
3.3.2	Confirm execution of the Attestation of Voluntary Implementation form to demonstrate eligibility under the Legal Requirement Test	No

Protocol Section	Eligibility Qualification Item	Apply Professional Judgment?
3.3.2	Verify that the project Monitoring Plan contains a mechanism for ascertaining and demonstrating that the project passes the Legal Requirement Test at all times	No
3.3.3	Confirm that disclosure has been made of any other credits or payments received in relation to the project area, and that these conform to the requirements of the protocol	No
3.5.1	Confirm that the Project Developer has executed a PIA with the Reserve	No
3.6	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
6	Verify that monitoring meets the requirements of the protocol. If it does not, verify that a variance has been approved for monitoring variations	No

8.6.2 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 (unless optional)	No
5	Verify that the emission factors are all correctly selected for the relevant parameters, both for baseline emissions and project emissions	No
5.1	Verify that the stratification procedures were carried out properly	Yes
5.2	Verify that the baseline emissions are properly aggregated (and pro-rated, if applicable)	No
5.2.1	Verify that the project employed the appropriate discount factors	No
5.3	Verify that the project emissions were calculated according to the protocol with the appropriate data	No
5.3.1	Verify that the Project Developer correctly monitored and quantified fires	No
5.3.2	Verify that the Project Developer correctly monitored, quantified, and aggregated fossil fuel use	Yes
5.3.3	Verify that the Project Developer correctly monitored and quantified fertilizer use	No
5.3.4	Verify that the Project Developer correctly monitored and quantified grazing activities	No
5.4	Verify that no reversals have occurred and that the correct contribution was calculated for the buffer pool	No

8.6.3 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 practices are in place 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 greenhouse gas reporting duties	Yes
6	Verify that all contractors are qualified for managing and reporting greenhouse gas emissions if relied upon by the Project Developer. Verify that there is internal oversight to assure the quality of the contractor's work	Yes
7.3	Verify that all required records have been retained by the Project Developer	No

8.6.4 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.
Anthropogenic emissions	GHG emissions resultant from human activity that are considered to be an unnatural component of the Carbon Cycle (i.e. fossil fuel destruction, de-forestation, etc.).
Biogenic CO_2 emissions	CO_2 emissions resulting from the destruction and/or aerobic decomposition of organic matter. Biogenic emissions are considered to be a natural part of the Carbon Cycle, as opposed to anthropogenic emissions.
Carbon rights	Legal ownership of carbon stored in pools located within the project area. Carbon rights may be separate from GHG reduction rights (defined below).
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.
Cooperative Developer	The entity responsible for management of a project cooperative. The Cooperative Developer may or may not be one of the Project Developers participating in the project cooperative.
Crediting period	The period of time over which CRTs may be quantified and registered under this protocol. For a grassland project, the crediting period may be a maximum of 50 years.
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: July 22, 2015.
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.
Grassland	An area of land dominated by native or introduced grass species with little to no tree canopy. Other plant species may include legumes, forbs, and other non-woody vegetation. Tree canopy may not exceed 10% of the land area on a per-acre basis.
Greenhouse gas (GHG)	Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), or perfluorocarbons (PFCs).
GHG reduction rights	Legal ownership of the GHG emission reductions resulting from avoided grassland conversion project activities on the project area during the reporting period. GHG reduction rights may be separate from carbon rights (defined above).

Grassland Owner	An individual or entity which has a right of ownership over a portion or all of the project area, or an ownership right whose exercise could reasonably be expected to impact soil carbon storage on a portion or all of the project area.
Grazing season	The period of time bounded by the first and last days of livestock grazing during the reporting period.
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 (MT, t, tonne)	A common international measurement for the quantity of GHG emissions, equivalent to about 2204.623 pounds or 1.102 short tons.
Methane (CH_4)	A potent GHG with a GWP of 21, 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.).
Non-reversible emission reductions	An emission reduction is not considered reversible if it represents the destruction or avoided emission of a GHG which does not rely on storage within a carbon pool. For example, the avoided emissions of N_2O due to cultivation activities are considered non-reversible.
Permanence period	The period of time following the crediting period during which the Project Developer must continue monitoring, reporting, and verification activities under this protocol. The permanence period for a grassland project is 100 years following the last issuance of CRTs related to reversible emission reductions.
Project area	The area defined by the physical boundaries of the project activities. The project area only contains land which meets the eligibility requirements of this protocol.
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 has title to the emission reduction credits issued under this protocol and undertakes a GHG project, as identified in Section 2.2 of this protocol. The Project Developer may also be the Cooperative Developer and/or a Grassland Owner.

Reporting period	The length of time over which GHG emission reductions from project activities are quantified. Under this protocol, the reporting period can be no more than 12 months.
Reversible emission reductions	An emission reduction is considered reversible if it represents an avoided emission or enhanced sequestration of carbon which must be stored in a carbon pool. For example, the avoided emissions of soil organic carbon due to cultivation activities are considered reversible, and the carbon must be permanently maintained through conservation of the project area.
Shrub	A woody perennial plant, generally more than 1.5 feet and less than 16.5 feet in height at maturity and without a definite crown (FAO, 2012). Shrubs will usually have multiple stems no more than 3 inches in diameter (Kuhns).
Tree	A woody perennial plant, typically large and with a well-defined stem or stems carrying a more or less definite crown with the capacity to attain a minimum diameter at breast height of 5 inches and a minimum height of 15 feet with no branches within three feet from the ground at maturity (Helms, 1998).
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.
Verification period	The length of time over which GHG emission reductions from project activities are verified. Under this protocol, the verification period can cover up to six reporting periods during the crediting period, and up to ten reporting periods during the permanence period.

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Appendix A Development of the Performance Standard

The Reserve assesses the additionality of projects through application of a Performance Standard Test and a Legal Requirement Test. The purpose of a performance standard is to establish a standard of performance applicable to all grassland projects that serves as a proxy for a significant threat of conversion of the project area to crop cultivation. If this standard is met or exceeded by the Project Developer, the project satisfies the criterion of "additionality."[82]

A.1 Components of the Performance Standard Test

The Grassland Project Protocol Performance Standard Test (PST) has two components:

1. Financial threshold
2. Suitability threshold

The intent of this two-part test is to create a standardized proxy for the complex decision-making process that leads to land use change. A project-specific approach would allow for the evaluation of all barriers to the project activity at the project site, but it would be fraught with subjectivity and uncertainty due to the counterfactual nature of the baseline scenario. Moreover, project-specific determinations of additionality tend to be very expensive and labor-intensive, thus rendering relatively low-volume projects, such as grassland projects, to be infeasible. While each individual component of the PST would not, on its own, be a rigorous test of the additionality of the project, the Reserve believes that, taken as a whole with the other requirements for eligibility (e.g. location, legal surplus), the PST does achieve such an outcome.

In addition to the two components of the PST, projects are subject to a location-based emission reductions threshold, discussed in Section 3.1. Although this eligibility screen is not part of the PST, it works in conjunction with the PST to identify eligible projects.

A.1.1 Location-Based Emission Reductions Threshold

This component of the eligibility screening is quantitative. Its premise is that projects should only be eligible if, based on the quantification methodology used by this protocol, the project will generate creditable emission reductions. The main focus of this protocol is the avoided emission and permanent protection of soil organic carbon (SOC). Thus, SOC is the focus of the emission reductions threshold.

For the purposes of this protocol, the U.S. has been stratified in order to enable the development of baseline and project emissions estimates that correspond to local soil conditions, climatic conditions, starting condition, and agricultural practices. A stratum represents a unique combination of these variables. All baseline modeling was performed at the stratum level, enabling the resulting emissions estimates to represent relatively fine distinctions in the primary drivers of variation in emissions. In total, this protocol established emissions estimates for 1,002 total strata within the U.S. By stratifying the country in this manner, the emissions estimates used in this protocol provide greater local accuracy and representation than would emission estimates generated at a national scale or with fewer variables. These variables act as filters that each brings greater specificity to the emissions estimates by more precisely estimating the conditions of the project. Land is first broken down by climate and

[82] See the Climate Action Reserve's Program Manual for further discussion of the Reserve's general approach to determining additionality.

geography, then further delineated by the major soil type and texture, and finally evaluated based on the previous land use.

The following variables were used to stratify the U.S:

- Geography and associated climate
- Soil texture
- Previous land use

A.1.1.1 Geography and Associated Climate

The first level of stratification used in this protocol delineates land based on its geography and associated climate, due to these factors important influence over carbon pools and sources in both natural and managed ecosystems.[83] Regional climate and geographic conditions are determined through the use of Major Land Resource Area (MLRA) designations, as defined by the U.S. Department of Agriculture, Natural Resources Conservation Services.[84] These designations are used for a variety of policy and planning decisions, as they represent information about land suitability for farming and other purposes. As such, they constitute a land area that has similar physical and climatic characteristics. In total, there are approximately 280 MLRAs in the U.S. However, some of these MLRAs contain very little cropland or grassland feasible for conversion. Appendix B provides an overview of the methodology used to screen out certain MLRAs based on the absence of significant areas of grassland or cropland, and constraints on data availability and modeling confidence.

A.1.1.2 Soil Texture

Soil texture has a significant impact on land productivity and carbon dynamics through influences on soil fertility and water balance and on soil organic matter stabilization processes.[85] Accordingly, the second level of stratification requires differentiating by soil texture. While successively finer delineations of soil type and texture would yield greater precision, this protocol limits the stratification of soils into three major classes of surface soil texture as defined by USDA. These are:

- Sand (sand, loamy sand, sandy loam)
- Loam (loam, silt loam, silt)
- Clay (clay, clay loam, sandy clay loam, silty clay loam, sandy clay, silty clay)

By adding soil texture to the stratification, the quantification is improved in two ways. First, the texture itself plays a considerable role in the carbon dynamics being modeled[86], allowing more refined and representative results. Second, defining the stratum with the soil texture limits the cropping systems and management practices that are modeled to those suitable to these soils by evaluating only those systems seen on other similar soils within the MLRA. Use of soil

[83] Schimel, D.S., Braswell, B.H., Holland, E.A., McKeown, R., Ojima, D.S., Painter, T.H., Parton, W.J., Townsend, A.R. (1994) *Climatic, edaphic, and biotic controls over storage and turnover of carbon in soils.* Global Biogeochemical Cycles 8, 279-293.

[84] United States Department of Agriculture, Natural Resources Conservation Service (2006) *Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin*. U.S. Department of Agriculture Handbook 296.

[85] Six, J., R.T. Conant, E.A. Paul, and K. Paustian (2002) *Stabilization mechanisms of soil organic matter: Implications for C-saturation of soils*. Plant and Soil 241:155-176.

[86] Hassink, J. (1997) *The capacity of soils to preserve organic C and N by their association with clay and silt particles*. Plant and Soil 191, 77-87.

texture therefore gives greater precision to the crop system inputs and resulting model accuracy.

A.1.1.3 Previous Land Use

Initial carbon pools at project commencement will be significantly influenced by previous land uses. Additionally, soil quality at project initiation influences nutrient inputs and farming practices in the baseline scenario. Because this protocol allows for the avoided conversion of grasslands with somewhat varied histories, the third level of stratification requires grasslands to be delimited by the duration of time it has been in a grassland state. This protocol defines the following two categories for grasslands:

- Greater than 10, but less than 30 years continuous grassland or pastureland
- Greater than 30 years continuous, long-term permanent grassland or pastureland

To develop this threshold, the baseline scenario was modeled for a period of 50 years for each individual stratum. The outputs from the models were averaged over 10 year periods to smooth out any inter-annual variability and stochasticity inherent in the modeling. Due to the specific characteristics of the individual strata and the common management practices in those areas, some strata exhibit SOC loss after conversion to cropland, some do not, and some show consistent SOC gains. A stratum may only be eligible if we have an emission factor that shows a baseline loss of SOC for the first 10 year emission factor period. If the stratum shows baseline SOC gains for an emission factor period, then the project crediting period will end prior to that emission factor period. Table A.1 and Figure A.1 show a summary of the outcome of this test.

Table A.1. Summary of Strata Eligibility Based on Emission Reduction Potential

Categories	Number of Strata in Each Category
Total possible strata	1,668
Strata with no data for modeling	667
Strata with no emission reductions in first 10 years	331
Potentially eligible strata	670

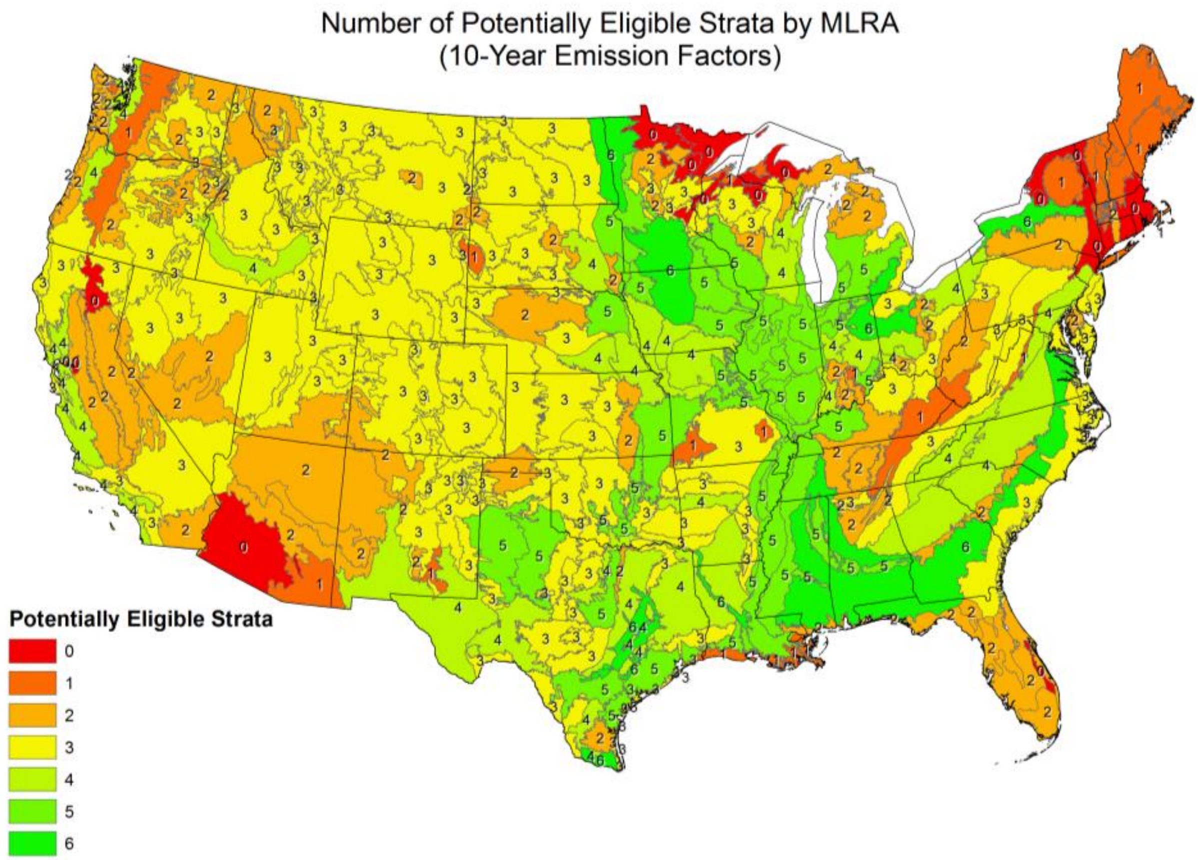

Figure A.1. Potentially Eligible Strata for Each MLRA

A.1.2 Financial Threshold

The first component of the PST is a financial threshold. The concept is that the monetary incentive provided by offsets is needed to counteract the existing financial incentive to convert grassland to cropland. The incentive to convert to cropland is thus viewed as a barrier to the project. As a proxy for this financial incentive, the Reserve uses the concept of the "cropland premium." The cropland premium for a county value of the cash rent rate for cropland compared to the cash rent rate for pastureland. In other words, the cropland premium represents the increased value (either as a percentage or in absolute dollars per acre) of land that is converted from pasture to crop production.

This approach is also utilized by avoided conversion project type in the Reserve Forest Project Protocol[87], which requires the Project Developer to obtain a certified real estate appraisal of the project area to identify the land's value as a forest (project scenario) and as the converted land use (baseline scenario). The percentage difference between these two must exceed 40% for eligibility and must exceed 80% to avoid the application of a discount, which is calculated on a sliding scale between the two thresholds.[88] The discount represents the uncertainty of the baseline conversion and recognizes that the threshold for the decision to convert will vary between landowners.

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[87] Climate Action Reserve, Forest Project Protocol Version 3.3 (November 15, 2012). Section 3.1.2.3.
[88] Climate Action Reserve, Forest Project Protocol Version 3.3 (November 15, 2012). Equation 6.14.

A.1.2.1 Calculating the Cropland Premium

The rent rate data are collected through the annual cash rent survey of the USDA National Agricultural Statistics Service (NASS)[89]. This dataset is robust and published on a regular, annual schedule. The cash rent survey provides a value, in dollars per acre, of the cash rent paid for non-irrigated cropland, irrigated cropland, and pastureland. The non-irrigated cropland rent rate is used as a proxy for the value of cropland. The pastureland rent rate is used as a proxy for the value of grassland. Cropland premiums were calculated by subtracting the average pastureland rent rate from the average non-irrigated cropland rent rates, then dividing by the average pastureland rent rate.

In order to smooth out inter-annual fluctuations and account for years with missing data, the financial threshold is based on an average of the cropland premium for the previous three years. If there are too few respondents in a particular county to ensure anonymity of the reported data, those counties are combined and averaged together by the NASS at the level of the Agricultural Statistics District (ASD) and identified in the data as “Other (Combined) Counties.” Thus, where a county did not have a value listed for a particular rent category for a particular year, the average for the ASD for that year was used. If there was no ASD average reported, the value was left out. When averaging the rent values over the three year period, only years with reported values were considered (i.e. “no value” was not considered to equal zero). For projects with start dates during the calendar year 2015, rent rate data from 2012-2014 were used. The data for 2015 will be released in September, 2015, at which point the Reserve will generate a new county eligibility table for projects with start dates during the calendar year 2016.

A.1.2.2 Setting the Threshold

Once the cropland premiums were determined, a policy decision was made as to where the threshold should be set. There are several options for how to consider the cropland premium as a proxy for the financial incentive to convert the project area. There were also several other decisions that ultimately influenced the threshold, such as the most appropriate geographic level of analysis (county, ASD, state, region) and the particular metric for the cropland premium (absolute $/acre or percent difference).

As the rent rate data are available at the county level, the Reserve chose to use this level for the analysis. Following the approach used in the Forest Project Protocol, the Reserve elected to continue to apply the financial threshold as a percent difference, rather than a dollar value, which limits the impact of other variables that affect land value. This approach is also used in the Avoided Conversion of Grasslands and Shrublands methodology adopted by the American Carbon Registry, although that methodology does not rely on a standardized assessment of land value.

The Forest Project Protocol sets a threshold of 40% premium for eligibility, and 80% premium for undiscounted eligibility. The ACR ACoGS methodology sets a threshold of 40% premium for eligibility and 100% premium for undiscounted eligibility. The Reserve has elected to adopt the thresholds described in the ACoGS methodology. Cropland premiums between these two values are subject to a discount on a sliding scale, following the guidance in Equation 5.7.

[89] Information available at: http://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Cash_Rents_by_County/index.asp. Accessed October 13, 2014.

Although the threshold will be applied to new rent rate data each year, the thresholds themselves will not change unless the Reserve carries out a new analysis and issues a new version of this protocol.

A.1.2.3 List of Eligible Counties

Once the threshold was determined, it was then applied to the rent rate data to determine the list of eligible counties. Following the procedures above, the Reserve determined the average cropland premiums for the most recent three year period (2012-2014). The financial thresholds were then applied to these data (Figure A.2). This exercise will be conducted annually as new rent rate data become available. For counties which are identified as having no data, a Project Developer may request that the Reserve examine the data for surrounding counties and determine whether the county may be considered eligible (and the appropriate value for DF_{conv}, if applicable). The revised list of eligible counties, along with their value for DF_{conv}, if applicable, will be published and be effective for new projects submitted during the following year. For example, the next dataset will be released in September of 2015; the new tables will be published in December 2015 and will be effective for projects submitted on or after January 1, 2016. The current tables, as well as any future updates, are available by individual request (email to policy@climateactionreserve.org or call (213) 891-1444) or for download at: http://www.climateactionreserve.org/how/protocols/grassland/.

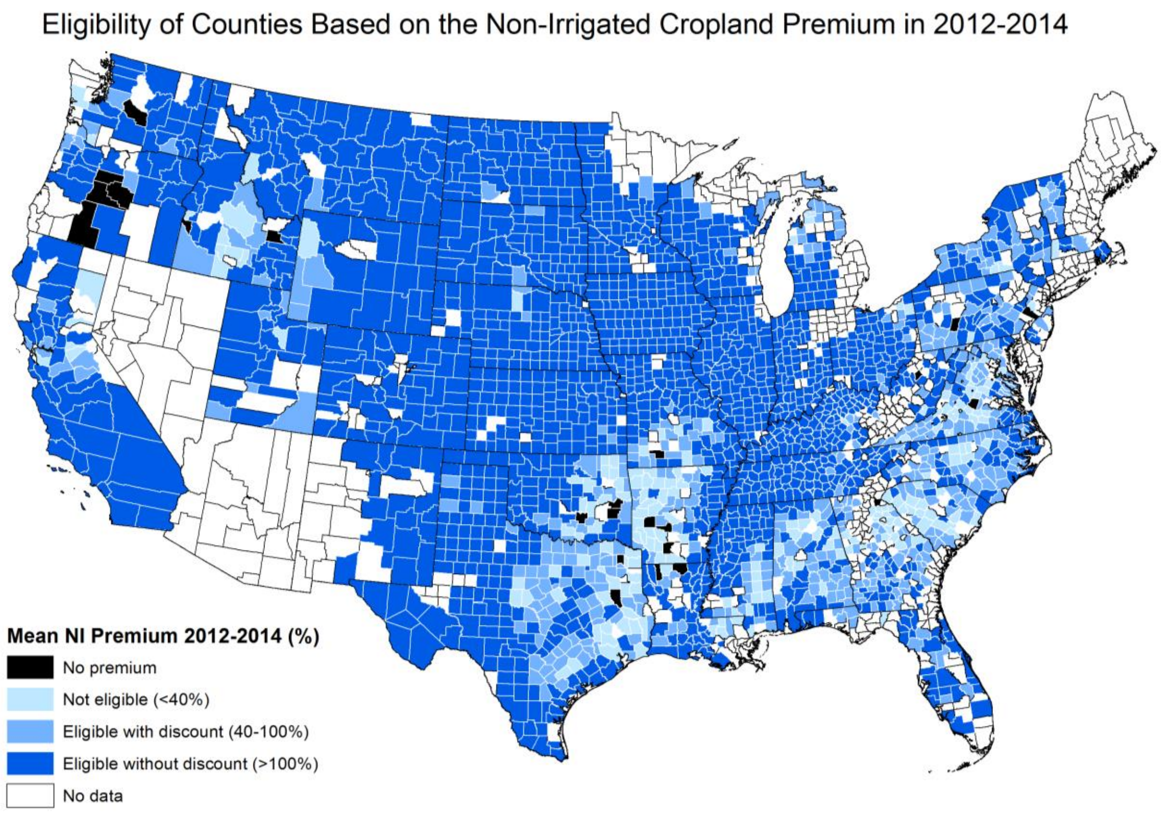

Figure A.2. Eligibility of Counties Based on the Financial Threshold for Additionality

A.1.3 Suitability Threshold

Projects should only be considered additional if the project area is actually suitable for conversion to crop cultivation. Otherwise, the baseline scenario is invalid, and the project area is not actually under threat of conversion to cropland. This is the premise behind the second component of the PST: the suitability threshold. There are numerous parameters (slope, drainage, rockiness, etc.) that contribute to the overall suitability of a parcel for crop cultivation. The Natural Resources Conservation Service (NRCS) Land Capability Classification (LCC) system[90] is widely used to simplify the description of land areas in regards to its suitability for cultivation. The Reserve has chosen to use the NRCS LCC system to assess the suitability threshold for grassland projects.

There are eight LCC classes, numbered I through VIII:

I. Soils have few limitations that restrict their use. (no subclasses)
II. Soils have some limitations that reduce the choice of plants or require moderate conservation practices. (all subclasses)
III. Soils have severe limitations that reduce the choice of plants or require special conservation practices or both. (all subclasses)
IV. Soils have very severe limitations that restrict the choice of plants, require very careful management, or both. (all subclasses)
V. Soils have little or no erosion hazard but have other limitations impractical to remove that limit their use largely to pasture, range, woodland, or wildlife food and cover. (subclasses w, s, c)
VI. Soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover. (all subclasses)
VII. Soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, or wildlife. (all subclasses)
VIII. Soils and landforms have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, or water supply or to esthetic purposes. (all subclasses)

In addition, there are four subclasses, indicated by letter:

(e) Erosion
(w) Excess wetness
(s) Problems in the rooting zone
(c) Climatic limitations

Crop cultivation is generally not recommended for land classified above Class IV. We have received stakeholder feedback that would push this threshold in both directions, some saying that no land above Class III should be cultivated, and others saying that they have seen Class V and VI land being actively converted. Recent research has supported this conclusion (Lark, Salmon, & Gibbs, 2015). The Reserve has chosen to rely on the general recommendation that classes above IV are not suitable for cultivation, while recognizing that land characteristics tend to be more heterogeneous than legal boundaries by allowing for small components of the

[90] "Land-Capability Classification," United States Department of Agriculture, Soil Conservation Service, Agriculture Handbook No. 210 (1962).

project area to be Class V or VI. As such, at least 75% of the project area must be LCC I-IV. Areas of LCC V-VI may not make up more than 25% of the total project area.

Determining the LCC for the project area is fairly straightforward using online tools provided by the NRCS (Web Soil Survey).[91] The LCC is provided for the land as irrigated and as non-irrigated. The non-irrigated classifications are typically lower, and thus more favorable for crop cultivation. Projects are to follow the non-irrigated LCC values unless they can prove that the project area has access to irrigation (see Section 3.3.1.2).

A.1.4 Complete Performance Standard Test

While neither of the individual components of this PST (or the eligibility section as a whole) would represent a comprehensive test for additionality on their own, when considered together, along with the eligibility limitations arising from the baseline stratification and modeling, they function to provide a holistic assessment of the threat of conversion of grassland to cropland in different areas of the country.

[91] Available at: http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm.

Appendix B Development of Standardized Parameters and Emission Factors

The approach outlined in this appendix was developed and executed by the Reserve's technical contractor WSP. The team consisted of Tim Kidman and Michael Mondshine at WSP, and Dr. Keith Paustian, Ernest Marx, Mark Easter, Ben Johkne and Stephen Williams at Colorado State University. The effort described here has resulted in a fixed collection of emission factors. The Reserve will seek to replicate this process at a later date in order to generate updated emission factors for AGC projects.

B.1 Introduction

This appendix describes the standardized assumptions used by the Reserve's technical contractor in modeling baseline GHG emissions from the conversion of grasslands to croplands. It also describes the modeling approach used by the Reserve's contractor to estimate the baseline emissions from soil processes, soil organic carbon, below-ground biomass, and fertilizer N_2O emissions using the DAYCENT model and a combination of national data sources. The methodology and standardized baselines are intended to provide accurate estimates of baseline emissions, give certainty over expected project outcomes, minimize project setup and monitoring costs, and reduce verification costs. The resulting emission rates, applied in the protocol as per acre emission factors, preclude the need for project-level modeling by Project Developers.

Modeling was performed using the same build of the DAYCENT model that is used for estimation of the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2013[92] (U.S. Inventory) compiled by EPA, and which is incorporated in USDA's entity level GHG quantification tool, COMET-Farm[93]. To compute the emissions associated with baseline conversion scenarios, the contractors utilized a DAYCENT model inputs database developed for the U.S. Inventory. The Inventory Database (IDB) was derived from national level soils and weather data sources, the USDA's Natural Resources Inventory (NRI) as well as ancillary data sets on actual agricultural management practices across the U.S. The NRI is a statistically robust stratified sampling design that includes land use and management data since 1979 at ca. 400,000 non-federal cropland and grassland locations.

The DAYCENT model (i.e. daily time-step version of the Century model) simulates cycling of carbon, nitrogen, and other nutrients in cropland, grassland, forest, and savanna ecosystems on a daily time step. This includes CO_2 emissions and uptake resulting from plant production and decomposition processes, and N_2O emissions from the application of synthetic and manure fertilizer, the retention of crop residues and subsequent mineralization, and mineralization of soil organic matter. DAYCENT simulates all processes based on interactions with location-specific environmental conditions, such as soil characteristics and climate.

[92] U.S. Environmental Protection Agency. (April 2014). *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2012 (April 2014)*. Available at: http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2014-Main-Text.pdf.

[93] Available at: http://cometfarm.nrel.colostate.edu.

B.2 Conceptual Overview

The approach to baseline determination and baseline modeling relies almost exclusively on geographic, historic, and physical characteristics of project parcels – most of which are publicly available in national geospatial databases – in assigning a baseline and associated emissions for any given project parcel. The methodology does not require project proponents to assert a single baseline cropping system, tillage, or management practice, support that assertion with detailed documentation, or justify why assertions represent reasonable baseline assumptions. Rather, this methodology establishes and dictates a composite baseline for any given parcel based on the practices documented on ecologically and geologically similar parcels using a variety of national databases. The methodology does not establish a single tillage practice, average fertilizer practice or other factors and use that as the baseline to model that single scenario to obtain baseline emission rates. Instead, the methodology acknowledges variability in practice, and the uncertainty associated with predicting future practice by assuming that there is a certain probability that the converted land could be managed in a variety of ways. The modeled management practices were generated based on survey data from land within the same eco-climatic region and soil type as the project parcel, based on the IDB and related data sources defined below.

Through this exercise 154,639 long term grassland points and 162,460 short term grassland points were modeled. The resulting emission rates for each stratum represent a weighted average of the potential practices on the parcel were it to be converted to cropland, with weighting based on the relative prevalence of each practice within the survey data. This approach to baseline determination eliminates subjectivity by standardizing the baseline determination based exclusively on stratification (see Section 5.1).

Similarly, the methodology does not require project proponents to execute complex biogeochemical process models. Instead, the methodology provides composite emission rates derived from these same biogeochemical process models utilizing geographic, soil, and cropping system assumptions representative of the project parcel.

Compared to the alternative in which project proponents would be responsible for asserting and documenting their baseline assumptions, and then conducting modeling themselves, this method has several important advantages, which are outlined in Section B.7.

B.3 Baseline Determination

The baseline for any given project parcel is defined probabilistically as a composite of the likely practices that might occur on that parcel were it to be converted from grassland to cropland.

The stratification regime defined in Section 5.1 of the protocol plays a fundamental role in establishing the range of practices and relative probabilities for baseline practice. Based on two of the three stratification elements – the Major Land Resource Area (MLRA) and the dominant surface soil texture from the Soil Survey Geographic Database (SSURGO)[94] – the U.S. was first broken into individual super-strata (unique combinations of these two variables).[95] By first stratifying by MLRA and surface soil texture, the U.S. is effectively subdivided into land areas

[94] Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. *Web Soil Survey*. Available online at http://websoilsurvey.nrcs.usda.gov/

[95] The third variable, previous land use, will be used later in the modeling of baseline emissions.

based on suitability to certain cropping systems and the practices associated with those systems in those geographies. Because MLRAs are based on agroecological classification, they define areas of similar climate, geomorphology, native vegetation and land management systems – all of which are the fundamental drivers of the biogeochemical processes involved in greenhouse gas emissions. Thus MLRAs are well-suited as stratification variables than other land area designations that are politically-based (e.g. states) or defined by a more limited set of criteria (e.g. NRCS Crop Management Zones (CMZ) based on farm management practices). By adding soil texture to the stratification, the quantification is improved in two ways. First, the texture itself plays a considerable role in the carbon dynamics being modeled[96], allowing more refined and representative results. Second, defining the stratum with the soil texture limits the cropping systems and management practices that are modeled to those suitable to these soils by evaluating only those systems seen on other similar soils within the MLRA. Use of soil texture therefore gives greater precision to the crop system inputs and resulting model accuracy.

For each unique super-strata, baseline practices were collected and estimated based on the real-world practices on agricultural land within the same super-stratum, as derived from the IDB, USDA National Resource Inventory (NRI), Economic Research Service Cropping Practice Survey (ERS), National Agricultural Statistics Service (NASS), and Natural Resources Conservation Service (NRCS).[97,98,99,100] These resources represent the best available data sources for agricultural practice in the U.S. A brief description of the relevant data sources is included below:

- **Inventory Database (IDB)**: Developed by Colorado State University as input data for the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2013 (US EPA, 2014), the IDB is derived from a variety of data sources including SSURGO, NRI, CTIC, ERS, NASS (described below). The IDB describes typical management practices for distinct regions and soils at MLRA and county scales.
- **Major Land Resource Area (MLRA)**: Agro-ecological classification developed NRCS that defines areas of similar climate, geomorphology, native vegetation, and land management systems across the U.S.
- **Soil Survey Geographic Database (SSURGO):** Developed and managed by NRCS, the SSURGO database contains geographically linked information on soil properties including texture. SSURGO data were collected by the USDA National Cooperative Soil Survey, covering the states, commonwealths and territories of the U.S. It was generated from soil samples and laboratory analysis, and represents the finest resolution soil map data available in the U.S.
- **National Resource Inventory (NRI):** Developed and managed by NRCS, the NRI is a statistical survey of land use and natural resource conditions on non-federal U.S. lands. It provides data on the status, condition, and trends of land, soil, water and related

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96 Hassink, J. (1997) *The capacity of soils to preserve organic C and N by their association with clay and silt particles*. Plant and Soil 191, 77-87.

97 U.S. Department of Agriculture (2013) *Summary Report: 2010 National Resources Inventory*, Natural Resources Conservation Service, Washington, DC, and Center for Survey Statistics and Methodology, Iowa State University, Ames, Iowa. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1167354.pdf.

98 USDA-ERS (2011) Agricultural Resource Management Survey (ARMS) Farm Financial and Crop Production Practices, available at: http://ers.usda.gov/data-products/arms-farm-financial-and-crop-production-practices.aspx.

99 USDA-NASS.

100 USDA-NRCS (2012) *Energy Estimator: Tillage*, available at: http://ecat.sc.egov.usda.gov/.

resources. The NRI utilizes established inventory sites for repeated sampling to provide national representation.

- **Conservation Tillage Information Center (CTIC)**: Since 1989, CTIC has conducted annual county-level surveys of tillage practices, by crop. These data are used to estimate probabilities for tillage practices and tillage transitions, for IDB locations within the surveyed counties.
- **Economic Research Service:** Housed within the USDA, ERS gathers a variety of data on crop and livestock practices through the use of its annual Agricultural Resource Management Survey (ARMS). ERS provides both annual and trend data, illustrating shifts in agricultural practice. ERS contains data on nutrient management, irrigation practices, and conservation practices.
- **National Agricultural Statistics Service (NASS):** Data on annual county-average crop area and yields from NASS are used as a secondary data source for availability control of model outputs.
- **Natural Resource Conservation Service (NRCS)/Energy Tools:** Data related to the energy inputs required for cropland management, including planting, tillage, fertilization, and harvesting. (http://energytools.sc.egov.usda.gov/)

For each super-stratum combination of MLRA and soil texture, relevant variables about baseline conditions were established using these data sources, with specific variables pulled from each as defined in Table B.1. In many cases, these variables are linked. For example, IDB data are used to establish the various cropping sequences, and then each crop is assigned nitrogen application rate distributions based on regional ERS data. The methodology used to link data and determine practices within regions is based on the methodology used in the U.S. Inventory. For further detail on how these datasets are used to set appropriate conditions, please refer to the sections Agriculture[101] and Land Use, Land-Use Change, and Forestry[102] in the U.S. Inventory.

Table B.1. Derivation of Baseline Scenario Input Variables

Baseline Variable	Data Source	Methodology
Tillage practice	IDB, CTIC	Assignment of tillage practices established using CTIC data in each super stratum and associated expansion factors. County-level CTIC data were recalculated at the MLRA level, with practices assigned to simulations through use of NIDB area-weights.
Typical cropping sequence	IDB, NASS	Assignment of each cropping sequence established using IDB data in each super stratum and associated area-weights, based on the cropping sequence from 2000-2007, supplemented by NASS data.
Fertilizer N application	ERS, NASS	Crop-specific N rates assigned based on state-level statistics, subdivided by MLRA, based on the most recent five years period.

[101] U.S. Environmental Protection Agency (2014) *Inventory of U.S. Greenhouse Gas Emissions and Sinks, Chapter 6-Agriculture*.
[102] U.S. Environmental Protection Agency (2014) *Inventory of U.S. Greenhouse Gas Emissions and Sinks, Chapter 7-Land Use, Land Use Change, and Forestry.*

Application of other nutrients/organic matter	NRCS	Livestock manure application frequency and rates estimated based on NRCS data and adjusted for county-level estimates of manure availability, based on the most recent five years period.
Irrigation practice	IDB	Irrigated vs. non-irrigated status are specified for each IDB location, based on the most recent five years period. For irrigated land, full irrigation (i.e. no significant water stress) is modeled.
Fuel consumption	NRCS	Energy consumption for each cropland management practice, based on CMZ, tillage practice, and crop.

Table B.2 provides an illustrative overview of some of the crop system data elements that went into the establishment of the composite baseline conditions for any given super-stratum, and a highly simplified example distribution. Based on the cropping systems established from historic data, additional nutrient input data were applied based on ERS and NASS data. In addition to the cropping and management variables extracted from these data sources, the methodology employs IDB area-weights to appropriately weight each practice based on its representativeness across the landscape. IDB area-weights are based on the spatial resolutions of source data, including NRI expansion factors, SSURGO map unit areas, and spatial scales of fertilizer and tillage data. The IDB area-weights indicate the number of acres across the landscape that each IDB location point represents.

The baseline for this example super stratum would be, for example, 20% constructed from data point #1 which is a practice that includes the use of no till on irrigated land, and with a crop rotation of corn, soy, corn, soy, fallow. This is based on the existence of an IDB location with that practice and its area-weight (100) being 20% of the aggregate of IDB area-weights (500) within the super stratum.

Table B.2. Example Crop Systems and Resulting Probabilities in Baseline

IDB Data Point	Tillage Practice	Irrigation Practice	Cropping System	Area-weight	Probability
#1	No Till	Irrigated	Corn, soy, corn, soy, fallow	100	20%
#2	Conservation Till	Not Irrigated	Corn, soy, fallow, wheat, soy	150	30%
#3	Conservation Till	Irrigated	Wheat, fallow, wheat, wheat, fallow	50	10%
#4	Standard Till	Not Irrigated	Corn, soy, fallow, wheat, soy	200	40%

Using this methodology, each project parcel effectively has multiple baseline scenarios. One way to think about this approach would be that for every acre of a project in the above example, 0.2 acres would be converted according to practice #1, 0.3 acres according to practice #2, 0.1 acres according to practice #3, and 0.4 acres according to practice #4.

B.4 Modeling Approach

In order to model baseline emissions for use in quantifying emission reductions, the composite baseline practices defined in Section B.3 were combined with climatic and initial condition inputs. Local weather data inputs were based on values from the North America Regional

Reanalysis Product (NARR).[103] Weather for each year in the future was modeled on actual weather from a year in the past (within the last 30 years). Thus, inputs such as temperature and precipitation should reflect recent trends. All modeling was performed using stochastic modeling techniques and the DAYCENT model to evaluate the change in carbon pools and emissions sources across multiple scenarios. More specifically, this was done by modeling the conversion to cropland of IDB locations throughout the U.S. that are currently categorized as grasslands. It includes analysis of the composite baselines defined in Section B.3 in a manner consistent with the compilation of the U.S. Inventory.

Modeling was conducted based on the strata delineated in Section 5.1 of the protocol, which include previous land use in addition to the variables used to define the super strata. For each stratum (unique combination of MLRA, soil texture, and previous land use), the following methodology was employed by utilizing the Colorado State University parallel computing capability, which includes dedicated database servers and a ca. 300 CPU computing cluster:

1. Grassland modeling points were pulled from the IDB or modified for modeling:
    a. For long term grassland (30+ years), all 154,639 IDB locations that have been continuous grassland were selected.
    b. For short term grassland (10-30 years) a period of 12-28 years of grassland management preceding project implementation was randomly assigned and area-weighted to 162,460 IDB locations in continuous cropland.
2. Initial carbon pools at project start were established for each data point based on soil data and a long-term spin-up of the DAYCENT model using practices defined in the preceding step.
3. For the 30+ year grassland baseline scenario, each IDB location was modeled forward applying the baseline practices determined in Section B.3 through the DAYCENT model for 50 years. The baseline practices for each IDB location were pulled at random without replacement.
4. For the 10-30 year grassland baseline scenario, each IDB location was modeled forward applying the cropping practices associated with that point in the IDB through the DAYCENT model for 50 years.
5. For the project scenario, each IDB location was modeled forward applying a continuation of the management practices established for the U.S. national GHG inventory analysis.
6. DAYCENT output was summarized as average annual change or emission rates in ten year increments for the following:
    a. Soil organic carbon[104]
    b. N_2O emissions (direct and indirect)
7. The extracted emissions in ten year increments were area-weighted based on IDB area-weights and averaged across points within the strata and translated into average annual per acre emission rates applicable to corresponding ten year increments.

[103] NOAA/OAR/ESRL PSD, *North America Regional Reanalysis Product*, available at: http://www.esrl.noaa.gov/psd/.
[104] Other related pools including above- and below-ground biomass flow through this pool in the modeled carbon balance. Accordingly, this pool is intended to represent net system emissions or sequestration over longer time horizons such as the 50 years modeled in this exercise.

The resulting emission rates are provided by stratum in a tabular form and included as lookup tables[105] where they function as per acre emission factors. A sample of the table format is provided as Table B.3 below.

Table B.3. Sample Output of Emission Factors

Stratum	Annual Emission Factor ($mtCO_2e$/acre)				
	Year 1-10	Year 11-20	Year 21-30	Year 31-40	Year 41-50

In addition to modeling baseline emissions, the DAYCENT modeling exercise was also performed to estimate project soil carbon emissions or sequestration, emissions from nitrous oxide, and dry matter estimates. The dry matter estimates are used in the quantification portion of this protocol to estimate CH_4 and N_2O emissions from burning on project lands.

Finally, fuel consumption was estimated by applying fuel consumption factors from the NRCS Energy Calculator to the practices modeled at each IDB location. The results from each IDB location in the baseline scenario were area-weighted based on IDB area-weights to estimate fuel consumption per acre for each stratum.

B.5 Results

Over 317,099 individual grassland points were modeled to calculate composite emission rates based on 31.7 million point years. However, emission rates have been provided for only a subset of strata within the continental U.S. where data was available and deemed reliable. In order to maintain data integrity and robustness of modeling results, certain strata for which there was limited data were evaluated, but output results were not included in the published tables of emission rates. Specifically, strata with less than ten assigned IDB locations in grassland were excluded due to low sample size. Because strata include soil type (texture), the paucity of points in many cases (especially for sandy and clayey soils) reflects the actual low occurrence of a particular soil type within a particular MLRA. Strata with 11-100 data points were considered to be of good availability, while those with more than 101 points were considered excellent data availability. The number of strata assigned to each category of data availability is summarized in Table B.4.

Table B.4. Stratum Availability

Count of strata deemed low availability (≤10 points), good availability (11-100 points), and excellent availability (>100 points)

	Clay		Sand		Loam		Total Strata
	10-30 years	30+ years	10-30 years	30+ years	10-30 years	30+ years	
≤10 Points	89	70	70	54	45	26	**354**
11-100 Points	64	79	98	77	73	61	**452**
>100 Points	73	77	58	95	108	139	**550**
TOTAL	**226**	**226**	**226**	**226**	**226**	**226**	**1,356**

[105] See the Reserve's Grassland Project Protocol webpage at: http://www.climateactionreserve.org/how/protocols/grassland/.

The maps in Figures B.1 through B.6 illustrate the distribution of the strata for which there was insufficient data to generate reliable emission rates (10 or fewer data points), and those for which there was good or excellent data availability.

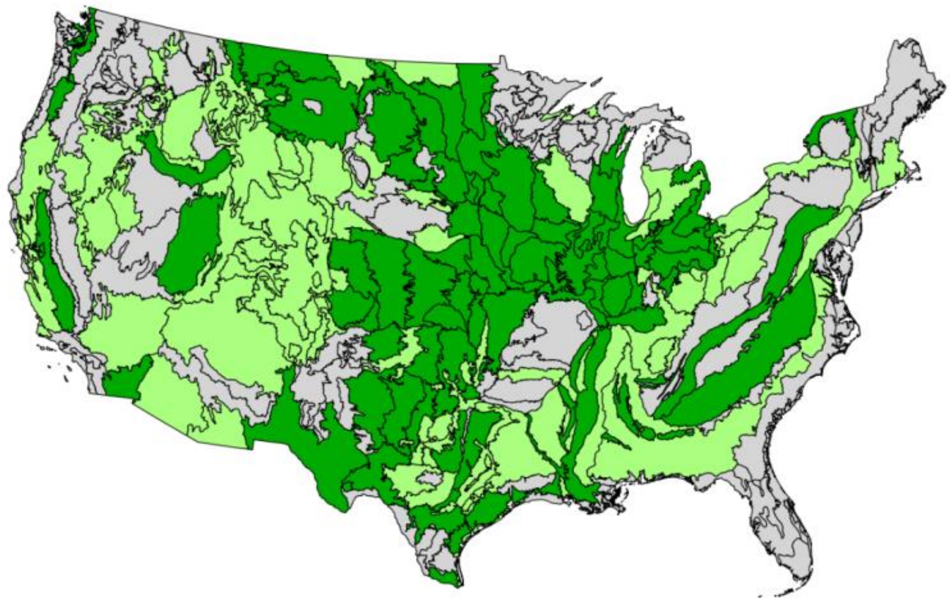

Figure B.1. Map of 10-30 Year Grassland Data Points on Clay Soils

Grey represents 10 or fewer points. Light green represents 11-100, and dark green represents greater than 100 data points. Emission rates have been provided for all green MLRAs.

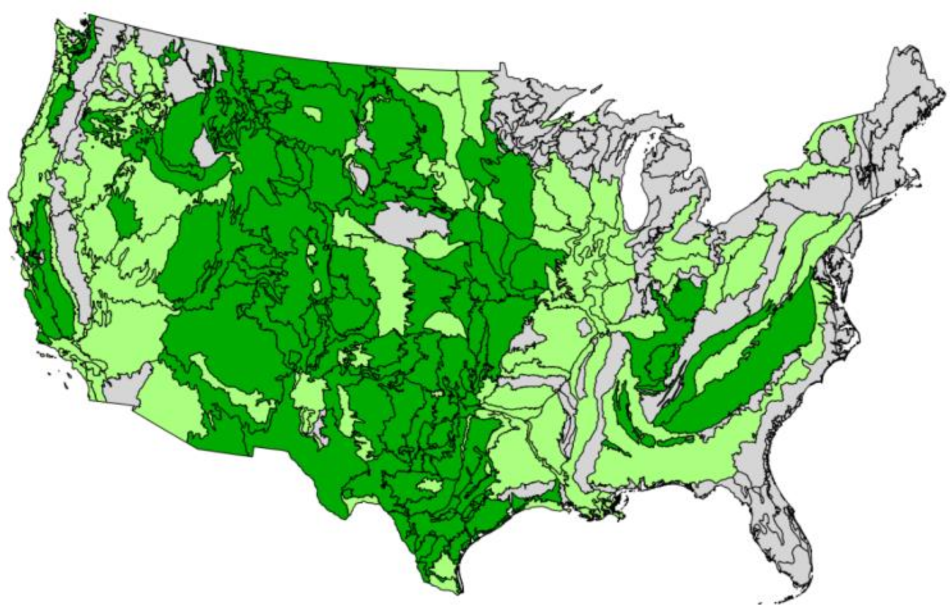

Figure B.2. Map of 30+ Year Grassland Data Points on Clay Soils

Grey represents 10 or fewer points. Light green represents 11-100, and dark green represents greater than 100 data points. Emission rates have been provided for all green MLRAs.

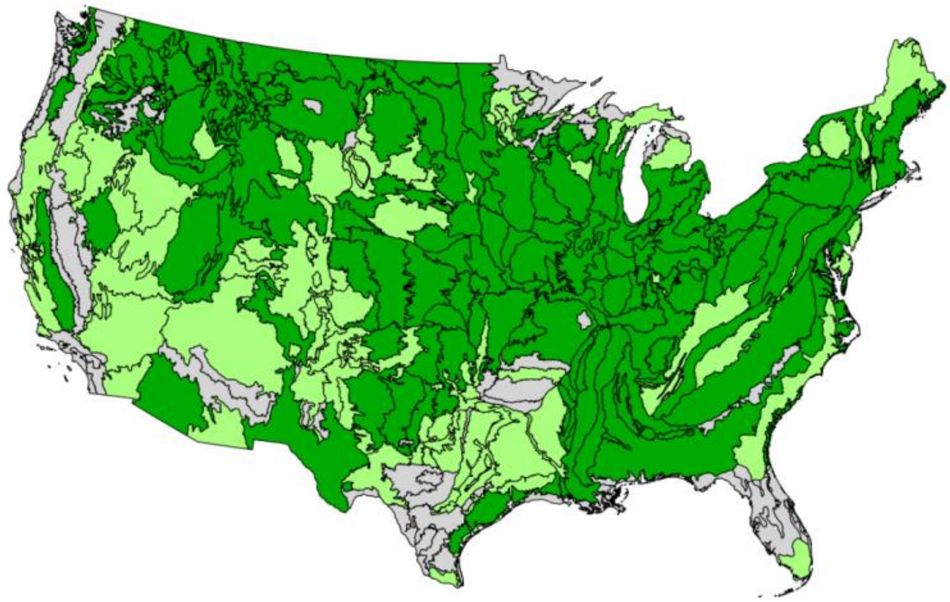

Figure B.3. Map of 10-30 Year Grassland Data Points on Loam Soils

Grey represents 10 or fewer points. Light green represents 11-100, and dark green represents greater than 100 data points. Emission rates have been provided for all green MLRAs.

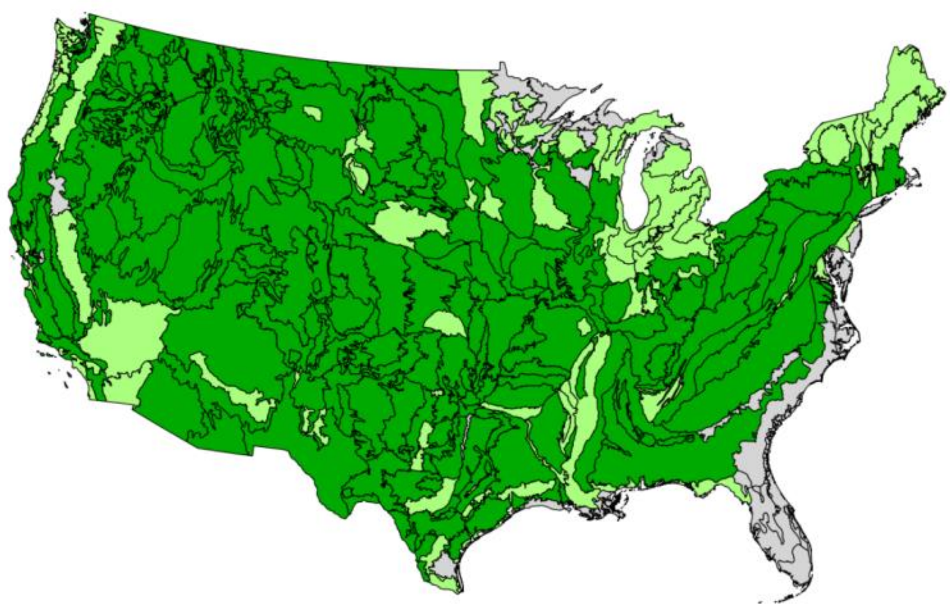

Figure B.4. Map of 30+ Year Grassland Data Points on Loam Soils

Grey represents 10 or fewer points. Light green represents 11-100, and dark green represents greater than 100 data points. Emission rates have been provided for all green MLRAs.

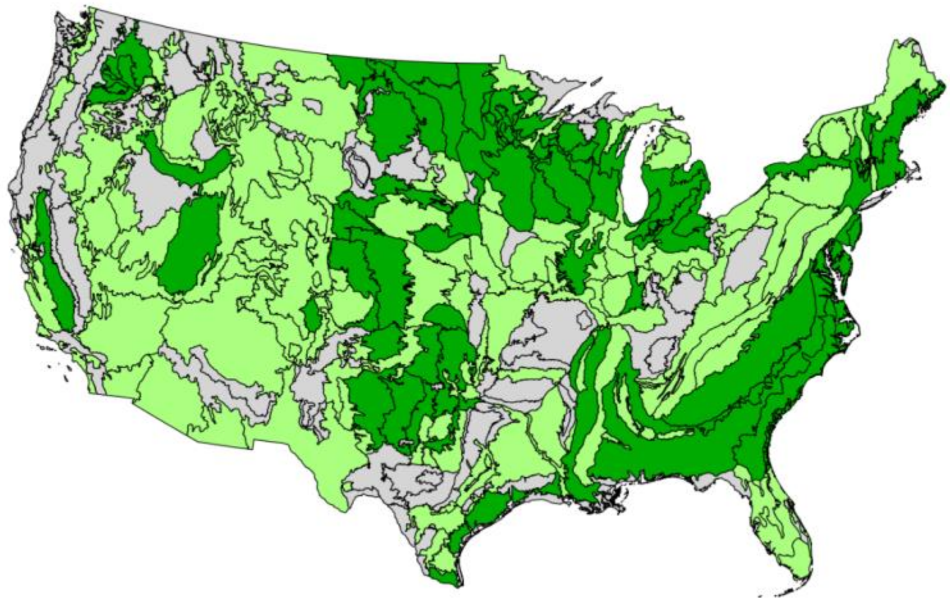

Figure B.5. Map of 10-30 Year Grassland Data Points on Sand Soils

Grey represents 10 or fewer points. Light green represents 11-100, and dark green represents greater than 100 data points. Emission rates have been provided for all green MLRAs.

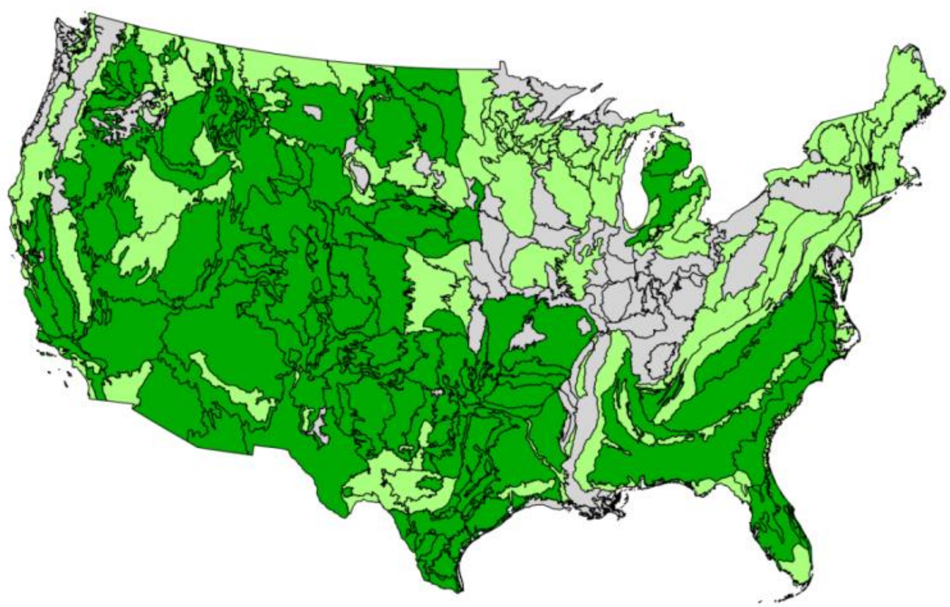

Figure B.6. Map of 30+ Year Grassland Data Points on Sand Soils

Grey represents 10 or fewer points. Light green represents 11-100, and dark green represents greater than 100 data points. Emission rates have been provided for all green MLRAs.

Due to the size and complexity of the emission rate output tables, results are not provided in the protocol, but instead are available for download in Microsoft Excel format from the Reserve's website.[106] In addition to the emission rate tables, there is an additional file that contains summary statistics for each stratum for which modeling was performed, which is available upon request. Although many variables went into the inputs for each modeling run, this file displays the percent of land that was modeled as irrigated in each stratum, as well as the distribution of crops that contributed to the composite baseline.

B.6 Uncertainty

Although some level of uncertainty is inherent in any modeling exercise, there are several important uncertainties unique to the establishment of baseline conditions and modeling performed over a 50 year horizon. Several sources of uncertainty are particularly noteworthy:

- **Tillage Practice.** The use of no-till and conservation tillage practices in the U.S. has been increasing in recent decades, and this trend is expected to continue. The USDA ERS evaluated tillage data for a variety of crops and geographies across the U.S. and found that no-till has increased at a rate of 1.5% per year between 2000 and 2007, though there is considerable variation across crops and regions. No-till agriculture, particularly when practiced over a prolonged time, has the potential to lower soil carbon emissions or increase sequestration.[107]
- **Fertilizer Use.** Inorganic and organic nitrogen are common inputs for many cropping systems in the U.S., and have considerable GHG impacts through both direct and indirect N_2O emissions. Nitrogen management best practices focus on minimizing excess nitrogen in the system by matching the rate, timing, placement, and source of nitrogen to the requirements of the crop system to efficiently utilize nitrogen and maximize crop yields. Despite data showing that nitrogen application rates on some crops have increased even since 1990 (e.g. corn, wheat)[108], emissions from this source may be flat or declining due to increased nitrogen use efficiency and yields. Shifts in practice and technology have the potential to reduce net N_2O emissions from fertilization per unit of yield.
- **Climate Change.** Over the coming decades, weather patterns across the country are expected to change in several ways. Temperatures are projected to rise; the intensity of the heaviest precipitation events is projected to increase; crop yields may be more strongly influenced by anomalous weather events; weeds, diseases and pests may increase crop stress; and other climate disruptions to agricultural production are projected to increase over the next 50 years.[109] These impacts will vary considerably across regions, and will have varied impacts on agricultural GHG emissions.

During the workgroup consultation process, the concept of including shifts in tillage practice and fertilizer use within the modeling environment was evaluated. However, because of data and

[106] See the Reserve's Grassland Project Protocol webpage at http://www.climateactionreserve.org/how/protocols/grassland/.
[107] USDA Economic Research Service (2010) *"No-Till" Farming is a Growing Practice*, available at: http://www.ers.usda.gov/media/135329/eib70.pdf.
[108] USDA Economic Research Service (2013) *Fertilizer Use and Price*, available at: http://www.ers.usda.gov/data-products/fertilizer-use-and-price.aspx.
[109] Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.

modeling limitations, uncertainty around inputs, and the assumptions required to conduct modeling that included these shifts, it was deemed more appropriate to account for the uncertainty outside of the modeling exercise rather than compromise the model's inherent strengths and data sources. Both tillage and nitrogen management practice will further interact with climate change and weather events, with the result being unknown net impacts to field-level GHG emissions. The quantification methodology includes a discount factor intended to conservatively address the uncertainty associated with these and other factors. The specific uncertainty related to these emission factors has not been quantified. In discussion with the contractor, the Reserve has set the discount as 1% per 10-year emission factor period. Thus, the discount increases as the time of quantification moves farther from the time the modeling was completed. If the Reserve is able to update this modeling exercise at a later date, then the discount for uncertainty will be reset for the new emission factors.

B.7 Justification for a Standardized Baseline

This section provides a brief overview of the benefits associated with use of a highly standardized approach to baseline determination and quantification of baseline emissions.

B.7.1 Transaction Costs and Verifiability

One of the primary goals to standardization is to cut down to the extent practicable on project costs and verification complexity. If the project proponent is required to assert the baseline cropping system and management practice, this would necessitate considerable costs both in project development and verification. Existing protocols rely on resources such as appraisals, government surveys, and universities in establishing baseline cropping systems. While government surveys provide some insight into dominant crops in a region, they are not generally differentiated by relevant soil characteristics, and do not reveal detailed crop rotation information nor do they link across variables (e.g. crop rotations and tillage practices). Further, while appraisals are useful in establishing that land may have a higher value as "cropland" versus grassland, it is unclear that these appraisals would consider specific cropping systems, inputs and management practices. Instead, these appraisals may assess only the publicly available rent information on cropland in the region, itself a composite of multiple practices.

In short, relying on project proponent assertions would require considerable project proponent resources to identify and document the likely cropping system, provided it can reliably be done at all. Additionally, the asserted crop system would need to be verified by the verification body, adding additional costs and uncertainty. Alternatively, the standardized approach does not require the project proponent to assert a baseline cropping system or management practice at all, or the verifier to assure this data. The baseline scenario and emissions estimates are defined exclusively based on geographic, historic, and physical characteristics of the project parcels, most of which are publicly available in national geospatial databases.

B.7.2 Customizability and Opportunity for Gaming

One potential shortcoming of a standardized approach to baseline determination and baseline emissions modeling is that it limits the opportunity for projects to be customized. Greater project proponent input provides greater opportunity to reflect specific knowledge or greater detail. For example, there may be characteristics of the land (e.g. slope) or local market (e.g. proximity to processing) that cannot be captured in the standardized methodology that nonetheless can reasonably be expected to influence cropping or practice.

However, this shortcoming of standardization is also a potential benefit in the ability it provides to avoid gaming. For example, if emission rates for two cropping systems are different, then gaming could occur if project proponents take steps to establish the system with higher emissions as their baseline. Given the complexity of verification and the potential methodological flexibility due to varying levels of data availability that may need to be afforded project proponents in establishing the baseline practice, it is possible that this gaming could occur without detection. Use of standardized composite baselines essentially eliminates this gaming risk by basing stratification and the determination of baseline emissions purely on geographic, historic, and physical characteristics of project parcels, most of which are publicly available in national geospatial databases.

B.7.3 Future Uncertainty

While the uncertainty of knowing what may occur on grassland directly following conversion is obviously significant, the uncertainty about what may occur 10 years or 20 years hence is even greater. Given a crediting period of 50 years, it is therefore extremely important that the baseline determination and associated baseline emissions are not overly influenced by short-term considerations.

Means of evaluating the highest value cropping systems are highly dependent on short-term projections about commodity and crop prices, which are subject to change in the future. As such, even if one knew with certainty that a parcel would be converted to a given crop rotation and management practice tomorrow, there is no reasonable way to know that it would persist in that manner for 10 or 20 years. As such, it is more reasonable to treat each parcel as essentially a composite of a multitude of crop systems in the area reflecting longer term practices and trends.

Appendix C Default Parameters and Emission Factors

C.1 Default Parameters and Emission Factors

Table C.1. CO_2 Emission Factors for Fossil Fuel Use[110]

Fuel Type	CO_2 Emission Factor (kg CO_2 / gallon)
Asphalt & Road Oil	11.95
Aviation Gasoline	8.32
Distillate Fuel Oil (#1, 2 & 4) (Diesel)	10.15
Jet Fuel	9.57
Kerosene	9.76
LPG (average for fuel use)	5.79
Propane	5.74
Ethane	4.14
Isobutene	6.45
n-Butane	6.70
Lubricants	10.72
Motor Gasoline	8.81
Residual Fuel Oil (#5 & 6)	11.80
Crude Oil	10.29
Naphtha (<401 deg. F)	8.31
Natural Gasoline	7.36
Other Oil (>401 deg. F)	10.15
Pentanes Plus	7.36
Petrochemical Feedstocks	9.18
Petroleum Coke	14.65
Still Gas	9.17
Special Naphtha	9.10
Unfinished Oils	10.34

[110] Taken from 40 CFR Part 98 Subpart C Table C-1.

Table C.2. Temperature-Dependent Values for ρ_{CH4} and MCF_{PRP}

Average Temperature During Grazing Season (round to the nearest value in the table) (°F)	Density of Methane (kg/m^3)[111,112]	MCF Value for Pasture/Range/Paddock Manure Management[113]
-40	0.84	0.010
-30	0.82	
-20	0.80	
-10	0.79	
0	0.77	
10	0.75	
20	0.74	
30	0.72	
40	0.71	
50	0.69	
60	0.68	0.015
70	0.67	
80	0.65	0.020
90	0.64	
100	0.63	

[111] Lemmon, E.W., Huber, M.L., McLinden, M.O. NIST Standard Reference Database 23: Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 9.1, National Institute of Standards and Technology, Standard Reference Data Program, Gaithersburg, 2013.
[112] Setzmann, U. and Wagner, W., "A New Equation of State and Tables of Thermodynamic Properties for Methane Covering the Range from the Melting Line to 625 K at Pressures up to 1000 MPa," J. Phys. Chem. Ref. Data, 20(6):1061-1151, 1991.
[113] Adapted from 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 10: Emissions from Livestock and Manure Management, Table 10.17.

Table C.3. Default Values for Parameters Related to Grazing Emissions by Livestock Category

Animal Category	$B_{0,l}$ (m^3 CH_4/kg VS added)	VS_l (kg/animal/day)	Nex_l (kg/animal/day)	$PEF_{ENT,l}$ (kg CH_4/animal/day)
Dairy Cows	0.24 [a]	See Table C.4	See Table C.4	See Table C.5
Dairy Heifers	0.17 [a]	3.436 [b]	0.1889 [b]	See Table C.5
Bulls		See Table C.4	See Table C.4	See Table C.5
Calves		0.909 [b]	0.053 [b]	0.0335 [d]
Beef Cows		See Table C.4	See Table C.4	See Table C.5
Beef Heifers		3.436 [b]	0.1889 [b]	See Table C.5
Steers		See Table C.4	See Table C.4	See Table C.5
Bison		See Table C.4	See Table C.4	0.2251 [d]
Goats		0.608 [c]	0.051 [c]	0.0137 [e]
Sheep	0.19 [a]	0.664 [c]	0.036 [c]	0.0219 [e]
Horses	0.33 [a]	2.745 [c]	0.135 [c]	0.0493 [e]
Mules and Asses		0.936 [c]	0.070 [c]	0.0274 [e]
Swine[114]	0.48 [a]	0.344 [c]	0.034 [c]	0.0041 [e]
Poultry[115]	0.39 [a]	0.058 [c]	0.002 [c]	0

Sources:

[a] (US EPA, 2014), Annex 3, Table A-203.
[b] Adapted from (US EPA, 2014), Annex 3, Table A-205.
[c] Adapted from (US EPA, 2014), Annex 3, Table A-204.
[d] State summaries of outputs of the Cattle Enteric Fermentation Model for 1989-2012 provided by U.S. EPA upon request of the Reserve.
[e] (US EPA, 2014), Annex 3, Table A-197.

Table C.4. Volatile Solids (VS_l) and Nitrogen (Nex_l) Excreted as Manure by State and Livestock Category for 2012 (kg/animal/day)[116]

State	Dairy Cows		Bulls		Beef Cows		Steers		Bison	
	VS_l	Nex_l	VS_l	Nex_l	VS_l	Nex_l	VS_l	Nex_l	VS_l	Nex_l
Alabama	5.859	0.356	4.712	0.227	4.556	0.200	2.650	0.112	4.712	0.227
Arizona	7.915	0.441	5.355	0.189	5.177	0.162	3.044	0.090	5.355	0.189
Arkansas	5.741	0.348	4.712	0.227	4.556	0.200	2.650	0.112	4.712	0.227
California	7.756	0.433	5.355	0.189	5.177	0.162	3.044	0.090	5.355	0.189
Colorado	7.912	0.441	5.355	0.189	5.177	0.162	3.044	0.090	5.355	0.189
Connecticut	7.077	0.405	4.739	0.230	4.583	0.203	2.667	0.115	4.739	0.230
Delaware	6.924	0.397	4.739	0.230	4.583	0.203	2.667	0.115	4.739	0.230
Florida	7.047	0.408	4.712	0.227	4.556	0.200	2.650	0.112	4.712	0.227
Georgia	7.069	0.408	4.712	0.227	4.556	0.200	2.650	0.112	4.712	0.227
Idaho	7.789	0.435	5.355	0.189	5.177	0.162	3.044	0.090	5.355	0.189
Illinois	7.001	0.400	4.498	0.233	4.350	0.205	2.522	0.118	4.498	0.233
Indiana	7.379	0.416	4.498	0.233	4.350	0.205	2.522	0.118	4.498	0.233

[114] The manure characteristics for swine are represented by an average of the values for different swine weight categories.
[115] The manure characteristics for poultry are represented by the values for turkeys.
[116] Environmental Protection Agency (EPA). U.S. Inventory of GHG Sources and Sinks 1990-2012 (2014), Annex 3, Table A-205.

State	Dairy Cows		Bulls		Beef Cows		Steers		Bison	
	VS_l	Nex_l	VS_l	Nex_l	VS_l	Nex_l	VS_l	Nex_l	VS_l	Nex_l
Iowa	7.455	0.422	4.498	0.233	4.350	0.205	2.522	0.118	4.498	0.233
Kansas	7.441	0.419	4.498	0.233	4.350	0.205	2.522	0.118	4.498	0.233
Kentucky	6.253	0.375	4.712	0.227	4.556	0.200	2.650	0.112	4.712	0.227
Louisiana	5.717	0.345	4.712	0.227	4.556	0.200	2.650	0.112	4.712	0.227
Maine	6.809	0.392	4.739	0.230	4.583	0.203	2.667	0.115	4.739	0.230
Maryland	6.935	0.397	4.739	0.230	4.583	0.203	2.667	0.115	4.739	0.230
Massachusetts	6.741	0.389	4.739	0.230	4.583	0.203	2.667	0.115	4.739	0.230
Michigan	7.858	0.438	4.498	0.233	4.350	0.205	2.522	0.118	4.498	0.233
Minnesota	6.998	0.400	4.498	0.233	4.350	0.205	2.522	0.118	4.498	0.233
Mississippi	6.094	0.367	4.712	0.227	4.556	0.200	2.650	0.112	4.712	0.227
Missouri	6.064	0.361	4.498	0.233	4.350	0.205	2.522	0.118	4.498	0.233
Montana	7.379	0.416	4.712	0.227	4.556	0.200	2.650	0.112	4.712	0.227
Nebraska	7.340	0.416	5.355	0.189	5.177	0.162	3.044	0.090	5.355	0.189
Nevada	7.707	0.430	4.498	0.233	4.350	0.205	2.522	0.118	4.498	0.233
New Hampshire	7.028	0.402	5.355	0.189	5.177	0.162	3.044	0.090	5.355	0.189
New Jersey	6.809	0.392	4.739	0.230	4.583	0.203	2.667	0.115	4.739	0.230
New Mexico	8.060	0.446	4.739	0.230	4.583	0.203	2.667	0.115	4.739	0.230
New York	7.433	0.419	5.355	0.189	5.177	0.162	3.044	0.090	5.355	0.189
North Carolina	7.337	0.422	4.739	0.230	4.583	0.203	2.667	0.115	4.739	0.230
North Dakota	6.951	0.400	4.712	0.227	4.556	0.200	2.650	0.112	4.712	0.227
Ohio	7.066	0.402	4.498	0.233	4.350	0.205	2.522	0.118	4.498	0.233
Oklahoma	6.639	0.386	4.498	0.233	4.350	0.205	2.522	0.118	4.498	0.233
Oregon	7.187	0.408	4.712	0.227	4.556	0.200	2.650	0.112	4.712	0.227
Pennsylvania	7.014	0.402	5.355	0.189	5.177	0.162	3.044	0.090	5.355	0.189
Rhode Island	6.752	0.392	4.739	0.230	4.583	0.203	2.667	0.115	4.739	0.230
South Carolina	6.700	0.392	4.739	0.230	4.583	0.203	2.667	0.115	4.739	0.230
South Dakota	7.384	0.416	4.712	0.227	4.556	0.200	2.650	0.112	4.712	0.227
Tennessee	6.450	0.383	4.498	0.233	4.350	0.205	2.522	0.118	4.498	0.233
Texas	7.524	0.424	4.712	0.227	4.556	0.200	2.650	0.112	4.712	0.227
Utah	7.444	0.419	4.712	0.227	4.556	0.200	2.650	0.112	4.712	0.227
Vermont	6.960	0.400	5.355	0.189	5.177	0.162	3.044	0.090	5.355	0.189
Virginia	6.839	0.400	4.739	0.230	4.583	0.203	2.667	0.115	4.739	0.230
Washington	7.877	0.438	4.712	0.227	4.556	0.200	2.650	0.112	4.712	0.227
West Virginia	6.240	0.367	5.355	0.189	5.177	0.162	3.044	0.090	5.355	0.189
Wisconsin	7.395	0.419	4.498	0.233	4.350	0.205	2.522	0.118	4.498	0.233
Wyoming	7.266	0.413	5.355	0.189	5.177	0.162	3.044	0.090	5.355	0.189

Table C.5. Average Daily Enteric Methane Emissions ($PEF_{ENT,l}$) by State and Livestock Category for 2012 (kg CH_4/animal/day)[117]

State	Dairy Cows	Dairy Heifers	Bulls	Beef Cows	Beef Heifers	Steers
Alabama	0.359	0.198	0.266	0.258	0.182	0.157
Arizona	0.417	0.171	0.284	0.275	0.195	0.169
Arkansas	0.325	0.183	0.266	0.258	0.182	0.157
California	0.409	0.171	0.284	0.275	0.195	0.169
Colorado	0.394	0.162	0.284	0.275	0.195	0.169
Connecticut	0.395	0.180	0.267	0.258	0.182	0.158
Delaware	0.386	0.180	0.267	0.258	0.182	0.158
Florida	0.432	0.198	0.266	0.258	0.182	0.157
Georgia	0.433	0.198	0.266	0.258	0.182	0.157
Idaho	0.410	0.171	0.284	0.275	0.195	0.169
Illinois	0.349	0.162	0.260	0.252	0.177	0.154
Indiana	0.368	0.162	0.260	0.252	0.177	0.154
Iowa	0.371	0.162	0.260	0.252	0.177	0.154
Kansas	0.371	0.162	0.260	0.252	0.177	0.154
Kentucky	0.383	0.198	0.266	0.258	0.182	0.157
Louisiana	0.324	0.183	0.266	0.258	0.182	0.157
Maine	0.380	0.180	0.267	0.258	0.182	0.158
Maryland	0.387	0.180	0.267	0.258	0.182	0.158
Massachusetts	0.376	0.180	0.267	0.258	0.182	0.158
Michigan	0.392	0.162	0.260	0.252	0.177	0.154
Minnesota	0.349	0.162	0.260	0.252	0.177	0.154
Mississippi	0.374	0.198	0.266	0.258	0.182	0.157
Missouri	0.302	0.162	0.260	0.252	0.177	0.154
Montana	0.368	0.162	0.284	0.275	0.195	0.169
Nebraska	0.366	0.162	0.260	0.252	0.177	0.154
Nevada	0.406	0.171	0.284	0.275	0.195	0.169
New Hampshire	0.392	0.180	0.267	0.258	0.182	0.158
New Jersey	0.380	0.180	0.267	0.258	0.182	0.158
New Mexico	0.425	0.171	0.284	0.275	0.195	0.169
New York	0.415	0.180	0.267	0.258	0.182	0.158
North Carolina	0.450	0.198	0.266	0.258	0.182	0.157
North Dakota	0.346	0.162	0.260	0.252	0.177	0.154
Ohio	0.352	0.162	0.260	0.252	0.177	0.154
Oklahoma	0.376	0.183	0.266	0.258	0.182	0.157
Oregon	0.379	0.171	0.284	0.275	0.195	0.169
Pennsylvania	0.391	0.180	0.267	0.258	0.182	0.158
Rhode Island	0.377	0.180	0.267	0.258	0.182	0.158
South Carolina	0.411	0.198	0.266	0.258	0.182	0.157
South Dakota	0.368	0.162	0.260	0.252	0.177	0.154
Tennessee	0.395	0.198	0.266	0.258	0.182	0.157

[117] Average daily emission factors are calculated as the average annual emission factor divided by 365.25. Annual emission factors for each state were provided by the U.S. EPA and are available upon request. The details regarding the development of these factors may be found here: U.S. Environmental Protection Agency (2014) *Inventory of U.S. Greenhouse Gas Emissions and Sinks, Annex 3-Methodological Descriptions for Additional Source or Sink Categories*. Section 3-10, pages A-240-A-256.

State	Dairy Cows	Dairy Heifers	Bulls	Beef Cows	Beef Heifers	Steers
Texas	0.426	0.183	0.266	0.258	0.182	0.157
Utah	0.392	0.171	0.284	0.275	0.195	0.169
Vermont	0.388	0.180	0.267	0.258	0.182	0.158
Virginia	0.419	0.198	0.266	0.258	0.182	0.157
Washington	0.415	0.171	0.284	0.275	0.195	0.169
West Virginia	0.348	0.180	0.267	0.258	0.182	0.158
Wisconsin	0.368	0.162	0.260	0.252	0.177	0.154
Wyoming	0.362	0.162	0.284	0.275	0.195	0.169

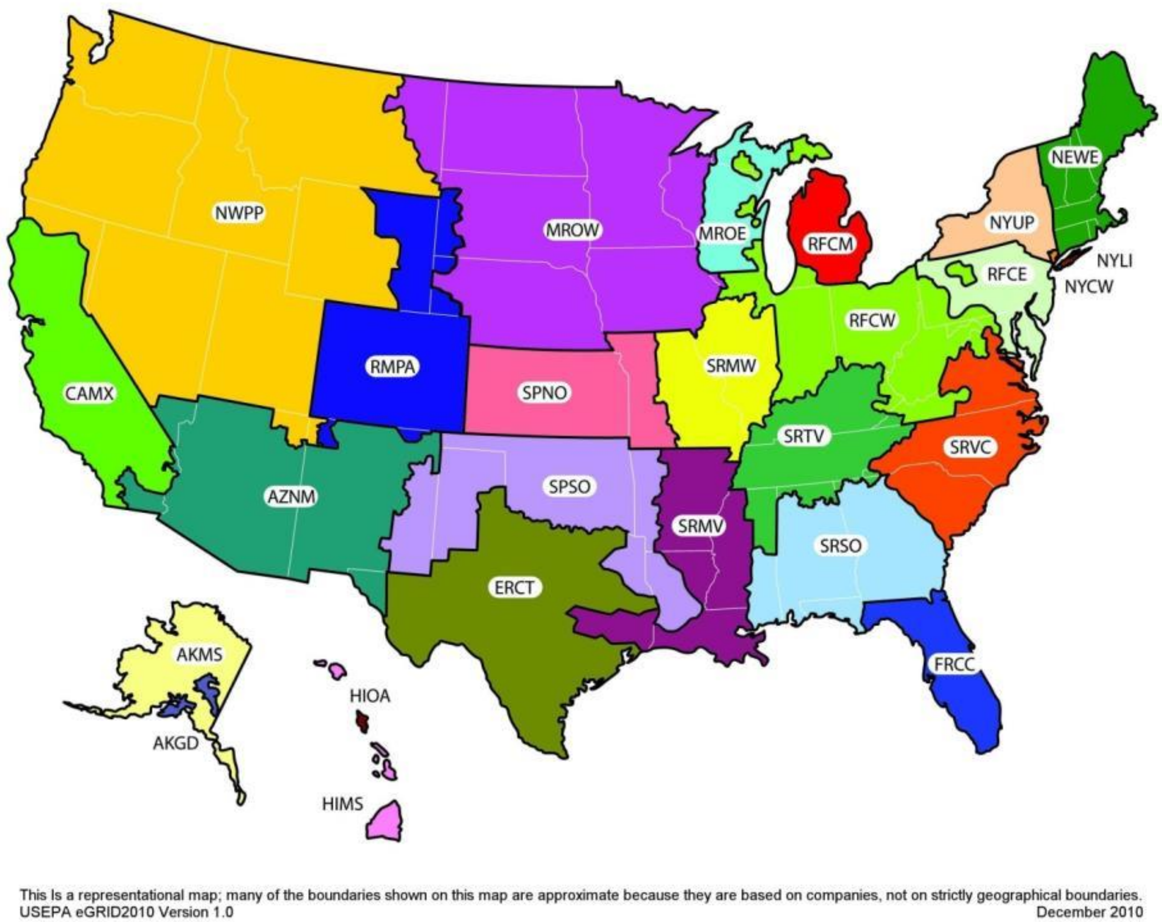

Figure C.1. Map of eGRID Subregions[118]

[118] If there is any ambiguity as to which subregion contains the project area, the subregion may also be determined using the zip code lookup function of the U.S. EPA Power Profiler, available at: http://oaspub.epa.gov/powpro/ept_pack.charts.

C.2 Development of Project Emission Factors for N_2O

To simplify the quantification of N_2O emissions from fertilizer and manure, the Reserve is relying on default values from the IPCC.[119] Because of this, the full equation necessary for accounting for emissions from nitrogen volatilization and leaching can be collapsed and simplified by combining multiple constants into a single constant.

Equation 5.11 uses a value of 0.012 to represent direct emissions and emissions from the volatilization of fertilizer. This value is derived thusly:

$$\boldsymbol{A} = \boldsymbol{B} + (\boldsymbol{C} \times \boldsymbol{D})$$

Where,
A = Emission factor for direct and volatilized emissions of N_2O from organic fertilizer (0.012)
B = Emission factor for direction emissions of N_2O from organic fertilizer (0.01)
C = Fraction of organic fertilizer lost to volatilization (0.2)
D = Emission factor for N_2O due to volatilization and deposition (0.01)

Equation 5.11 uses a value of 0.00225 to represent emissions from the leaching of fertilizer. This value is derived thusly:

$$\boldsymbol{Leach} = \boldsymbol{E} \times \boldsymbol{F}$$

Where,
Leach = Default factor for the fraction and emission factor for N_2O emissions due to leaching (0.00225)
E = Fraction of organic fertilizer lost to leaching (0.3)
F = Emission factor for N_2O due to leaching (0.0075)

Equation 5.12 uses a value of 0.22 to represent direct emissions and emissions from the volatilization of manure nitrogen. This value is derived thusly:

$$\boldsymbol{G} = \boldsymbol{H} + (\boldsymbol{I} \times \boldsymbol{J})$$

Where,
G = Emission factor for direct and volatilized emissions of N_2O from manure (0.22)
H = Emission factor for direction emissions of N_2O from manure (0.02)
I = Fraction of organic fertilizer lost to volatilization (0.2)
J = Emission factor for N_2O due to volatilization and deposition (0.01)

Equation 5.12 uses a value of 0.00225 to represent emissions from the leaching of manure nitrogen. This value is the same as the leaching value derived for fertilizer, above.

[119] 2006 IPCC Guidelines for Greenhouse Gas Inventories, Chapter 11, Table 11.3.

Appendix D Legal Instruments

Registration of a grassland project under this protocol requires the use of a number of specific legal instruments. This appendix provides additional guidance on the intent and usage of these instruments, as well as any requirements for their use with a grassland project. Table D.1 lists the related legal instruments and their relevant protocol sections.

Table D.1. Legal Instruments Relevant to Grassland Projects

Legal Instrument	When Required	Protocol Section(s)
GHG reduction rights contract	Required when ownership of GHG emission reduction rights are not determined in the conservation easement	2.3.2
Indemnification agreement	Required when there are multiple Grassland Owners who are not party to the legal instruments related to the project	2.3.2
Cooperative contract	Optional	3.2.1
Conservation easement	Required, unless project area is owned by the Federal government	2.2, 3.2, 6.2.1.2
Qualified Conservation Easement	Required, unless project area is owned by the Federal government	3.5.1
Project Implementation Agreement	Required for all projects	3.5.2
Reserve attestations (title, voluntary implementation, regulatory compliance)	Required for all projects	2.3.2, 3.3.2, 3.6
Instruments associated with concurrently-joined conservation programs	Required only if the project area is enrolled in other conservation payment/credit programs	3.3.2.1

D.1 GHG Reduction Rights Contract

Purpose: This contract is required in order to clearly establish ownership over the GHG emission reductions associated with the grassland project. In order to meet the definition of a Project Developer, an entity must be able to demonstrate ownership of the GHG emission reductions associated with the project. Unless existing contracts specify otherwise, it is assumed that the Grassland Owner holds the rights to any GHG emission reductions that would be issued under this protocol. However, the recording of a conservation easement may create the expectation, on the part of the easement holder, that they hold ownership rights that include the GHG emission reductions. In addition, either the Grassland Owner or the easement holder may wish to transfer these rights to a third-party Project Developer. The grantee of the GHG Reduction Rights contract will be the Project Developer of record (the Account Holder) with the Reserve, and will be the entity to which the CRTs are issued upon successful registration of a reporting period. The Project Developer is also the entity who will execute the Project Implementation Agreement.

Parties involved: Grassland Owner, Project Developer, easement holder.

Timing: Ownership of the GHG emission reductions associated with the project activities must be documented during project verification.

Notes:

- May be a standalone document, or it may be incorporated into another legal document, such as the project's conservation easement. A standard, short form version is included as Exhibit B to the PIA.
- Must clarify the ownership of the GHG emission reductions at the time of their creation, rather than just the sale of those credits
- Must clearly define ownership of rights for GHG reductions related to the project activities
- Must be signed by the Grassland Owner, the easement holder, and the Project Developer.
- Must include clauses that specify steps to be taken if ownership changes for either the land, the GHG reduction rights, or the conservation easement
- Recommended inclusions:
    - Description of the project area
    - Description of the offset project and the offset project registry
    - Reference to the GPP as the method of quantifying GHG emission reductions
    - Specific reference to sources of GHG emissions which are covered by GHG assessment boundary for the GPP
    - Discussion of responsibilities in the event of a reversal (see Section 5.4)
    - Any potential exclusions (i.e. GHG or other benefits not covered by this contract)

D.2 Indemnification Agreement

Purpose: Where there may be multiple entities who could meet the definition of Grassland Owner, the Reserve must be indemnified against future GHG reduction claims by those entities which are not acting as Grassland Owner for the purposes of the protocol, and are not party to the GHG reduction rights contract.

Parties involved: Grassland Owner, Project Developer, Climate Action Reserve.

Timing: This agreement must be executed following the initial verification, prior to registration by the Reserve.

Notes: Must indemnify the Reserve in connection with any claims brought by other grassland owners or would-be grassland owners against the Reserve.[120]

D.3 Cooperative Contract

Purpose: For projects participating in a cooperative, this is a contract between the Project Developer and the Cooperative Developer. In general, this contract lays out the terms of the PD's participation in the cooperative. However, its relevance for this protocol is its usefulness as a clear signal from the PD of their intent to initiate a GHG offset project. This is particularly useful for determining the project start date, in order to ensure the additionality of the project (see Section 3.2.1).

Parties involved: Project Developer, Cooperative Developer.

[120] A sample indemnification agreement is available at: http://www.climateactionreserve.org/how/protocols/grassland/.

Timing: If being used to denote the project start date, then the notarization date of this contract will be chosen by the CD as a date which will result in more efficient management of the cooperative. This date can be no earlier than the earliest recorded easement on any project in the cooperative.

Notes:

- This contract is only required for projects which wish to use it to denote the project start date. In those cases, this contract must be notarized

D.4 Qualified Conservation Easement (QCE)

Purpose: The conservation easement is the principle mechanism by which the project area is protected against land use change during the project period, and in perpetuity. The QCE is a label applied to a conservation easement whose terms either explicitly prevent reversals of CRTs by referencing the Grassland Project Protocol, or implicitly prevent reversals of CRTs by including land use limitations which are sufficient to prevent land use that would disturb soil carbon in the project area.

Parties involved: Grassland Owner, easement holder, Project Developer (optional).

Timing: In most cases, the execution of the QCE will denote the project start date. In all cases the QCE must be executed prior to completion of the initial verification.

Notes:

- It is recommended that the QCE also include clear discussion of both the carbon rights and the GHG emission reduction rights, as defined in Section 9 (see section above regarding the GHG emission reduction rights contract).
- It is required that the QCE include enforceable provisions for the ongoing monitoring of compliance with the terms of the easement.
- It is recommended that access rights be granted to the Project Developer and the Reserve for the purposes of monitoring and enforcing the provisions of the Protocol.
- If the project is at all likely to include livestock grazing, it is recommended that the QCE include prescriptive guidance for grazing management which explicitly limits grazing intensity.
- It is recommended that the QCE make reference to and incorporate the PIA.

D.5 Project Implementation Agreement (PIA)

Purpose: The PIA is a contract between the Reserve and the Project Developer which binds the Project Developer to the terms of the protocol, including the avoidance of and compensation for reversals, and the monitoring of the project during the permanence period. If the Grassland Owner is the Project Developer, they may elect to have the PIA recorded on the deed to the property, thus binding the landholder to the protocol and reducing the risk of uncompensated reversals.

Parties involved: Project Developer, Climate Action Reserve.

Timing: The PIA is executed during the initial verification of the project, prior to registration and CRT issuance. The terms of the PIA are applicable for 100 years following the issuance of CRTs. The PIA is updated at each subsequent registration in order to extend its term to cover the new CRT issuance, as well as to potentially reflect any changes in project ownership.

Notes:

- The Recorded PIA includes a clause specifying whether the PIA may be subordinated to any subsequent deed restrictions. The Project Developer will choose whether to use the Type I (not able to be subordinated) or the Type II (able to be subordinated) clause. Use of the Type II clause results in a value of 0.1 for the risk of financial failure in the calculation of the project's contribution to the risk buffer pool. Use of the Type I clause results in a value of 0 for this parameter.
- The Contract PIA, where the project area itself is not bound by the contract, always results in a value of 0.1 for the risk of financial failure in the calculation of the project's contribution to the risk buffer pool.

D.6 Reserve Attestations

Required attestations:

- Attestation of Title
- Attestation of Voluntary Implementation
- Attestation of Regulatory Compliance

Purpose: These attestations are legal documents whereby the Project Developer legally attests to the truth of the statements and facts necessary to support the conclusions of a positive verification report. The Attestation of Title confirms that the Project Developer is the legal owner of the rights to the GHG emission reductions represented by the CRTs which will be issued into their account. The Attestation of Voluntary Implementation confirms that the project passes the Legal Requirement Test. The Attestation of Regulatory Compliance confirms that the project met the eligibility requirements of Section 3.6 during the reporting period(s).

Parties involved: Project Developer.

Timing: These attestations are completed during verification and apply to a specific period of time for which CRTs are to be issued. The Attestation of Title and Attestation of Regulatory Compliance are completed at every verification. The Attestation of Voluntary Implementation is only completed during the initial verification.

D.7 Other Instruments Associated with Concurrently-Joined Conservation Programs

Purpose: If a project area is enrolled in any other credit or payment program, the contracts or legal instruments associated with that program is relevant to the verification of the offset project. These contracts or instruments must be disclosed to the verifier during the verification process. The verifier shall assess each payment or crediting program against the guidance of Section #, conferring with the Reserve for guidance where appropriate.

Parties involved: Grassland Owner, others as relevant.

Timing: At every verification.