Grassland Project Protocol

Avoiding Greenhouse Gas Emissions Related to the Conversion of Grassland to Cropland in the U.S.

Workgroup Comment Draft

January 2015

Expected Effective Date: July 22, 2015

Notes on the Workgroup Comment Draft

This document represents a complete protocol draft which requires additional feedback to polish into a final protocol for adoption. Workgroup members have the opportunity to review and comment on this draft prior to its review by the public at large.

The comment period for the Grassland Workgroup members is January 16 – February 16. We will schedule a final Workgroup meeting during this period to give the Workgroup an opportunity to discuss their comments with the Reserve staff. **Written comments must be received by the close of business (6:00 pm Pacific) on Monday, February 16**. Comments should be organized by protocol section, and may be submitted to policy@climateactionreserve.org, preferably in the form of a MS Word document. Reserve staff will review Workgroup comments and implement any necessary protocol changes. Workgroup members will also have the option of submitting comments during the public comment period, expected to begin in mid-March. If you have any questions, please contact Heather Raven at heather@climateactionreserve.org or (213) 542-0282.

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Abbreviations and Acronyms

AGC	Avoided Grassland Conversion
CARB	California Air Resources Board
CDL	Cropland Data Layer
CDM	Clean Development Mechanism
CH_4	Methane
CO_2	Carbon dioxide
CRP	Conservation Reserve Program
CRT	Climate Reserve Tonne
EPA	U.S. Environmental Protection Agency
GHG	Greenhouse gas
GRP	Grassland Reserve Program
IPCC	United Nations Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
lb	Pound
MT (t)	Metric ton (or tonne)
N_2O	Nitrous oxide
NRCS	Natural Resources Conservation Service
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

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.

The Climate Action 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 CRT) generated from such projects in a transparent, publicly-accessible system. The Climate Action Reserve is a private 501(c)(3) nonprofit 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.[1]

[1] 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. 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 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 we cannot know exactly how much carbon would have been released if a particular area of land were converted, 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 carbon stocks and avoiding cultivation activities on an eligible project area, carried out through a conservation easement or transfer to public ownership. The project area must be grassland, as defined below, and it must be suitable for conversion to crop cultivation, as defined in Section 3.3.1.3. Projects are not eligible on organic soils (histosols), including areas identified as wetlands or peatlands. The project area must have been in continuous grassland cover for at least 10 years prior to the project start date.

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 legumes, forbs, and other non-woody vegetation. Tree canopy may not exceed 10% of the land area on a per-acre basis. Projects may not employ synthetic fertilizer additions or irrigation. In addition, the project area must have been privately-owned prior to the project start date.

An AGC project may involve seeding, application of organic fertilizer (i.e. manure, compost, etc.), moderate haying, or moderate livestock grazing as part of the project activity. 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 6.3. 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 areas to be considered an entirely different land use, (i.e., not grassland).In such cases, the area used for such activities may not be considered to be part of the project area.

2.2.1 Defining the Project Area

An eligible project area consists of natural 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 geographic boundaries defining the project area must be described in detail at the time a grassland project is listed on the Reserve. The boundaries must be defined using a georeferenced map, or maps that displays 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.

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. Non-contiguous sections of the project area must pass the same Performance Standard Test, as described in Section 3.3.1, to be considered a single project area. For example, if the proposed project area contains two non-contiguous parcels in different counties, and those counties fall into different categories of the Financial Threshold under the Performance Standard Test, those parcels would be considered two different project areas.

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.

2.3 Project Ownership Structures and Terminology

A Grassland Owner is an individual or a corporation or other legally constituted entity, city, county, state agency, or a combination thereof that has legal control of any amount of soil carbon within the project area. A public entity may only be a Grassland Owner if such ownership is initiated as part of the project activities. Control of soil carbon means the Grassland Owner has the legal authority to affect changes to soil carbon quantities, either through mineral rights or other grassland management or land-use rights. For the purposes of this protocol, control of soil carbon occurs through fee ownership and/or deeded encumbrances, such as conservation easements. A lessee is not a Grassland Owner, but may work as an agent of the Grassland Owner to implement a project.

Multiple Grassland Owners may exist with respect to a single grassland project, since control of soil carbon may be associated with fee ownership or through one or more deeded encumbrances that exist within a project area, any one of which may convey partial control of the project's soil carbon. Any unencumbered soil carbon is assumed to be controlled by the fee owner. Individuals or entities holding *de minimis*[2] interests in the soil carbon are precluded from the definition of a Grassland Owner. Such an individual or entity is only considered to have a *de minimis* interest if it can be demonstrated (per guidance in Section 3.5.2) that the exercising of their rights will not result in a reversal which is greater than the materiality threshold applicable to that project.[3] Surface or sub-surface interests such as mining, wind power, or oil and gas rights may or may not result in a *de minimis* interest, depending on the nature and extent of the rights.

A Project Operator is the Grassland Owner (or one of the Grassland Owners) of the project area who is responsible for undertaking the grassland project and registering it with the Reserve. The Project Operator must execute the Project Implementation Agreement (PIA) with the Reserve (see Section 3.5.3). If there are any Grassland Owners which are not party to the PIA, the Project Operator must also execute an indemnification stating that the Project Operator will indemnify the Reserve in connection with any claims brought by other Grassland Owners or would-be Grassland Owners against the Reserve. The Project Operator is also responsible for the accuracy and completeness of all information submitted to the Reserve, and for ensuring compliance with this protocol.

Whenever there are multiple Grassland Owners for a given project area, the Project Operator must also secure an agreement from all other Grassland Owners that assigns authority to the Project Operator to undertake a grassland project within the defined project area.

The Reserve maintains the right to determine what individuals or entities meet the definition of Grassland Owner.

The project developer is an entity, or individual, that submits a project for listing and registration with the Reserve, and is responsible for all project reporting and verification. The project developer may be the Project Operator, or it may be a third-party entity. If the project is part of a project cooperative (see below), the project developer will be the cooperative developer. If the Project Operator chooses to use a third-party project developer (or cooperative developer), the Reserve will interact with that third party, but the Project Operator will still be ultimately responsible for their project. A Project Operator may also serve as his/her own cooperative developer, representing both his/her own project area as well as one or more other projects, as defined in Section 2.3.1. All information submitted to the Reserve on behalf of the Project Operator shall reference the Project Operator, who is ultimately responsible for the accuracy and completeness of the information submitted, and for ensuring compliance with this protocol. Figure 2.1 depicts the relationships between these entities and possible project ownership structures.

In all cases, the Project Operator 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 Operator must attest that no other entities are reporting or claiming (e.g. for voluntary reporting

[2] *De minimis* control includes access right of ways and residential power line right of ways.
[3] Information regarding the materiality threshold for Reserve projects is outlined in the Reserve Verification Program Manual, available at: http://www.climateactionreserve.org/how/verification/verification-program-manual/.

or regulatory compliance purposes) the GHG reductions caused by the project.[4] The Reserve will not issue CRTs for GHG reductions that are reported or claimed by entities other than the Project Operator (e.g. Grassland Owners that are not the Project Operator or others not designated as the project developer). In the case of project cooperatives, each Project Operator must submit an attestation. Attestations may be submitted by a third party developer, but must be signed by the Project Operator.

A "project cooperative" or "cooperative" is a collection of two or more individual grassland projects that share a common project developer, (referred to as the "cooperative developer,") and engage in joint reporting and verification. Participation in a cooperative can improve the cost-effectiveness of smaller grassland projects while maintaining rigor and consistency in overall reporting and verification.

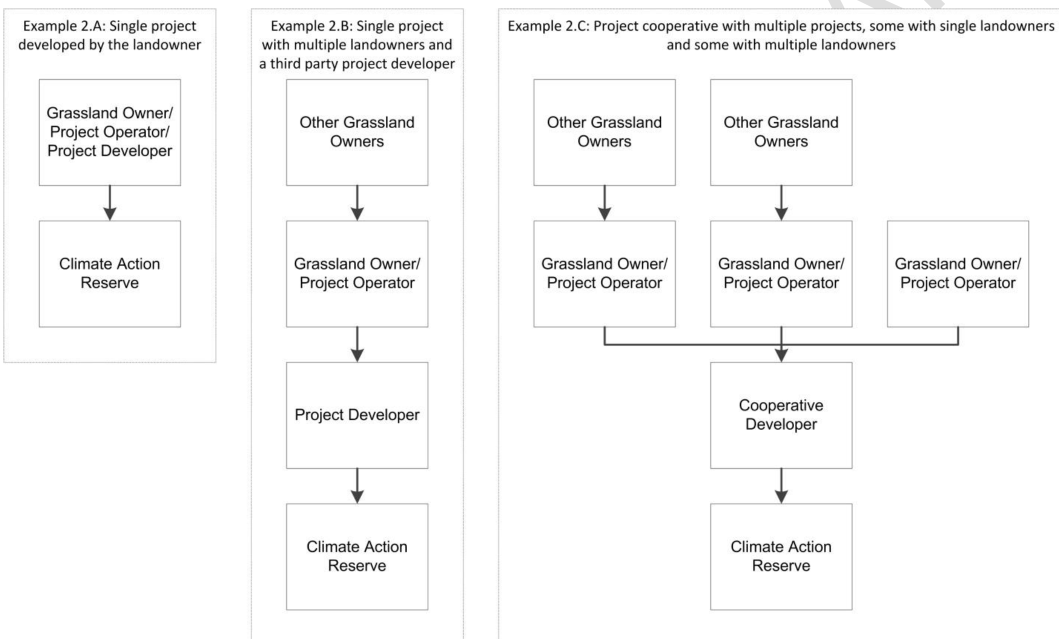

Figure 2.1. Grassland Project Ownership Structures and Terminology
The arrows represent a flow of information. Each box represents a single entity or individual.

2.3.1 Qualifications and Role of Cooperative Developers

A "cooperative developer" is defined as the project developer for a project cooperative, i.e., two or more individual grassland projects that report and verify jointly. A project cooperative may consist of grassland projects involving multiple sets of different grassland owners. A cooperative developer must meet the requirements of a project developer and must have an account on the Reserve.

[4] This is done by signing the Reserve's Attestation of Title form, available at: http://www.climateactionreserve.org/how/program/documents/

A cooperative developer must open a Cooperative Developer account on the Reserve and must remain in good standing throughout the duration of the cooperative(s). Failure to remain in good standing will result in all account activities of the participant projects in the cooperative 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 Operators (see following section on Joining a Cooperative)
- Select a single verification body for all grassland projects enrolled in the cooperative in any given verification period
- 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 6.6, 7.4, and 8.1)
- Maintain a Reserve account

Project Operators are ultimately responsible for timely submittal of all required forms and complying with the terms of this protocol. Project Operators may designate a project developers or cooperative developer to manage the flow of documents and information to the Reserve. Cooperative developers may also engage in project development, provide monitoring/reporting services, assist in facilitating verification activities, and provide other services for the Project Operator. The scope of cooperative developer services should be determined by the Project Operator and the cooperative developer and reflected in the contracts between the Project Operator and the cooperative developer.

2.3.2 Forming or Entering a Cooperative

Individual grassland projects may join a cooperative by being included in the cooperative's Project Submittal Form[5] (if joining a cooperative at initiation) or by being added through the New Grassland Project Enrollment Form (if joining once the cooperative is underway).

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 start accruing toward the cooperative's CRTs in the reporting period during which the transfer occurred. A transfer into a cooperative is effective at the next registration following the acceptance of the transfer form by the Reserve.

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.

[5] All forms referenced in this section are available at: http://www.climateactionreserve.org/how/program/documents/.

2.3.3 Leaving a Cooperative or Termination of Contract between a Project Operator and Cooperative Developer

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.

Due to the permanence requirements in Section 3.5, project activities on an individual project area that are terminated prior to the completion of the minimum time commitment are subject to the termination penalties in Section 5.4.1. However, individual Project Operators 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 Operator must submit a Project Submittal Form to the Reserve, noting that it is a "transfer project" and identifying the cooperative from which it transferred.

Projects can switch their participation to another cooperative (effective as specified above) if, and only if:

1. The project area changes ownership and the new owner, tenant or manager has other project areas already enrolled with a different Cooperative Developer.
2. The original cooperative is terminated (e.g. goes out of business).
3. The Cooperative Developer breaches its contract with the Project Operator and the contract is terminated.

Individual projects seeking to change cooperatives under one of the above allowed circumstances must submit a Cooperative Transfer Form to the Reserve prior to enrolling in the new cooperative. In the case of termination of a contract between the Project Operator and cooperative developer or if a cooperative developer ceases to exist or is unable to provide aggregation services, the Project Operator may choose a replacement cooperative developer. For projects which lose a cooperative developer in this manner, 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 7.3. The project developer (or the new cooperative 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. Prior to submittal of this next report the Project Operator must submit either a Cooperative Transfer Form or a Project Submittal Form, depending upon whether they intend to join a new cooperative or continue as a standalone project, respectively.

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 qualified conservation easement or transfer to public ownership*
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 for time within the crediting period*
Eligibility Rule V	Permanence	→	*Maintain stored carbon for at least 100 years following issuance of CRTs*
		→	*Complete PIA to legally agree to permanence requirements*
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 must be implemented on private land, unless the land is transferred to public ownership as part of the project. Grassland projects in tribal areas must demonstrate that the land within the project area is owned by a tribe or private entities.

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.

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 a private entity are still required to record a conservation easement, as described above, prior to the initial registration.

Comment [MD1]: WORKGROUP

Are there any problems with this start date definition that you can think of?

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.[6] 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.

To qualify for use for a grassland project under this protocol, a conservation easement must explicitly (1) refer to, and incorporate by reference, the terms and conditions of the PIA agreed to by the Project Operator (see Section 3.5.3), thereby binding both the grantor and grantee—as well as their subsequent assignees—to the terms of the PIA for the full duration of the grassland project's minimum time commitment, as defined in Section 3.5 of this protocol; (2) make all future encumbrances and deeds subject to the PIA; and (3) make the Reserve a third party beneficiary of the conservation easement.

In order to serve as the project start date, the recorded easement must cover the entire project area and must make explicit that the Grassland Owner has the right to be issued any and all carbon credits that may be issued from the project area. If an easement is not clear on this point the Reserve requires that the easement or agreement be amended to clarify which party has the exclusive right to be issued CRTs. The Reserve maintains the exclusive right to determine whether this issue is clear. The easement must address which party has the right to be issued carbon offset credits without restricting who may otherwise own, sell, trade, etc. the offset credits. Sample language is included below:

> *"TITLE TO CARBON OFFSET CREDITS. The [grantor/grantee- i.e., whichever party to the easement or agreement is the Grassland Owner]: 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."*

If the other party to the easement is unwilling to establish or amend the easement to grant this right with respect to the soil carbon prior to the initial verification, the project area is not eligible for a grassland project. If an easement requires an amendment, the recordation date of the unamended easement shall be used to determine the project start date.

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

[6] 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/.

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.[7] Projects may always be submitted for listing by the Reserve prior to their start date.

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 four parts:

1. Emission reductions threshold,
2. Financial threshold,
3. Suitability threshold, and
4. Existing baseline practice threshold.

3.3.1.1 Emission Reductions Threshold

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. For the project to be eligible during the reporting period, all project strata must have an emission factor for baseline soil organic carbon.[8] Certain strata may only be eligible for a period of time that is less than a full crediting period, in which case those strata would have a crediting period that is shorter than the maximum allowable crediting period (Section 3.4). If a project contains strata which are not eligible for the same amount of time, the project may continue without further quantification of emission reductions for those strata which are ineligible.

3.3.1.2 Financial Threshold

Options for the Financial Threshold

The Reserve has proposed two different options for the financial threshold for additionality. The first option (blue text) is a percentage-based evaluation, patterned after the existing policy in the Reserve Forest Protocol and the ACR ACoGS methodology. The second option (green text) is a dollar-per-acre-based evaluation, linking the value of cropland with the conversion rate. **Please evaluate these two options independently and provide feedback regarding your preference and your specific recommendations for improving your preferred option.**

[7] Please refer to the most current version of the Reserve Program Manual, available at http://www.climateactionreserve.org/how/program/program-manual/.
[8] All stratum and county level information is contained in a separate document, "Grassland Parameters by Strata and Counties," available at: http://www.climateactionreserve.org/how/protocols/grassland/.

Note that the "appraisal option" is included regardless of which method is chosen for the standardized threshold.

OPTION 1: PERCENTAGE

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 0 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 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 different county than the main body of the project area, then eligibility must be assessed separately for that county. If the other county is not eligible, then that portion must be removed from the project area. A document and a spreadsheet with the eligibility status of each county is available from the Reserve website.[8] 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 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.

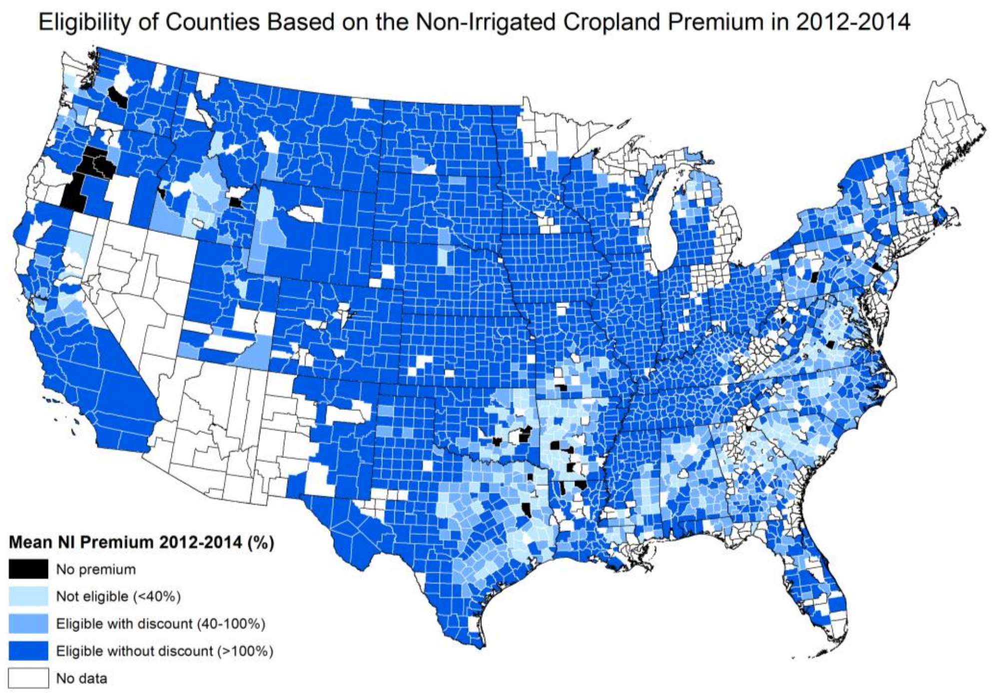

Figure 3.1. County Eligibility Map for Project Submitted during the Calendar Year 2015 (threshold option 1)

OPTION 2: CONVERSION RATE TREND

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 difference in the value (represented by land rental rates in $/acre) of cropland and 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 $11.50 are eligible without any discount for uncertainty
2. Projects in counties with a cropland premium greater than $8.50 but less than $11.50 are eligible, but must apply a discount to their baseline emissions (see Section 0 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 $8.50 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 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 different county than the main body of the project area, then eligibility must be assessed separately for that county. If the other county is not eligible, then that portion must be removed from the project area. A document and a spreadsheet with the eligibility status of each county is available from the Reserve website.[8] 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 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.

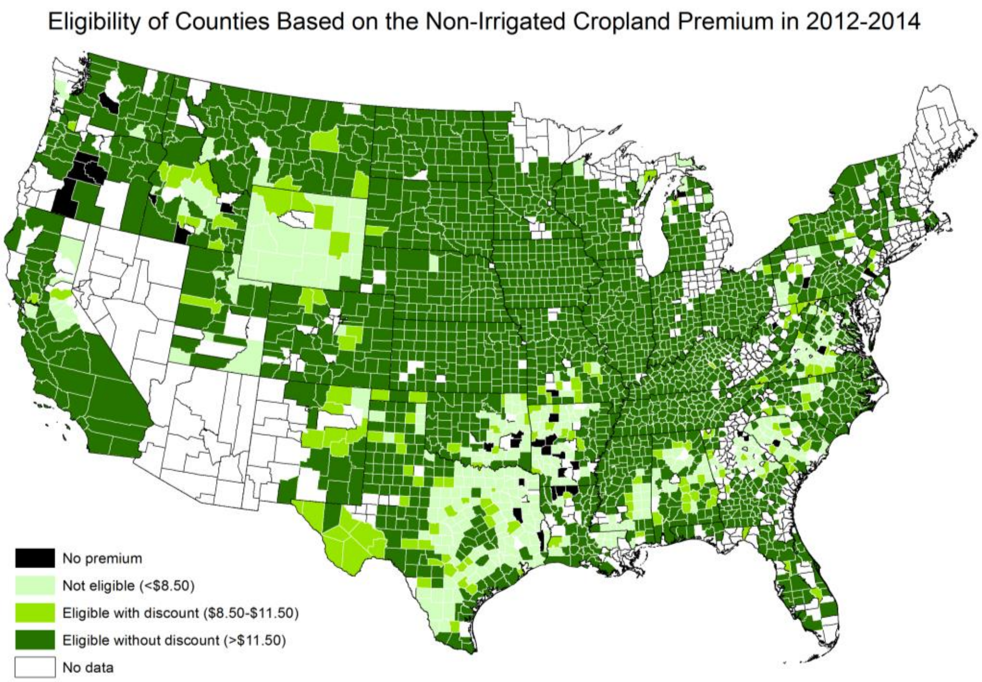

Figure 3.2. County Eligibility Map for Project Submitted during the Calendar Year 2015 (threshold option 2)

APPRAISAL OPTION

If using step 4 above, a project may satisfy the financial threshold if the Project Operator provides an up-to-date[9] real estate appraisal for the project area (as defined in Section 2.2.1) indicating the following:

[9] An appraisal will be considered "up-to-date" if it is finalized no more than 6 months before or after the project start date.

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[10]:
   a. Appraisal reports shall be prepared and signed by a Licensed or Certified Real Estate Appraiser in good standing.
   b. Appraisal reports shall include descriptive photographs and maps of sufficient quality and detail to depict the subject property and any market data relied upon, including the relationship between the location of the subject property and the market data. 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.

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

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 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 3.3.1.2.

The appraisal must be conducted in accordance with the Uniform Standards of Professional Appraisal Practice[11] and the appraiser must meet the qualification standards outlined in the Internal Revenue Code, Section 170 (f)(11)(E)(ii).[12]

3.3.1.3 Suitability Threshold

The project area must be suitable for conversion to cropland. Suitability is demonstrated by determining the Land Capability Classification[13] (LCC) for the soil map units that are contained within or intersect the project area. At least 90% of the total area contained within the project boundary must be identified as Class I, II, III, or IV. Portions of the project area may be identified as Class V or VI as long as there are no continuous areas of these classes that exceed 5% 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:

- Certified assessment of the existence of available groundwater, and the legal ability 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
- 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 adjacent parcels

Comment [MD2]: This list needs some expert assessment

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

[12] 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."

[13] 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.

3.3.1.4 Existing Baseline Practice Threshold

Another indicator of pressure to convert the project area to cropland is the existence of the baseline practice (i.e. crop cultivation) on other areas with similar soil and climatic characteristics. The Reserve has developed a standardized screen for the presence of cultivated areas within the same soil survey region unit as the project area. The map units are those of the Digital General Soil Map of the United States (STATSGO2).[14] The presence of cultivation within each map unit was calculated using the Cultivated Layer generated from the 2013 Cropland Data Layer, developed by the USDA National Agricultural Statistics Service.[15] Map units are deemed eligible if at least 5% of the land area is already identified as cultivated. Figure 3.3 shows the map units which are eligible based on existing crop cultivation activity. This map is available for download in order for project developers to determine the status of the project area.[16] The Reserve will update this analysis when an updated cultivated layer is made available.

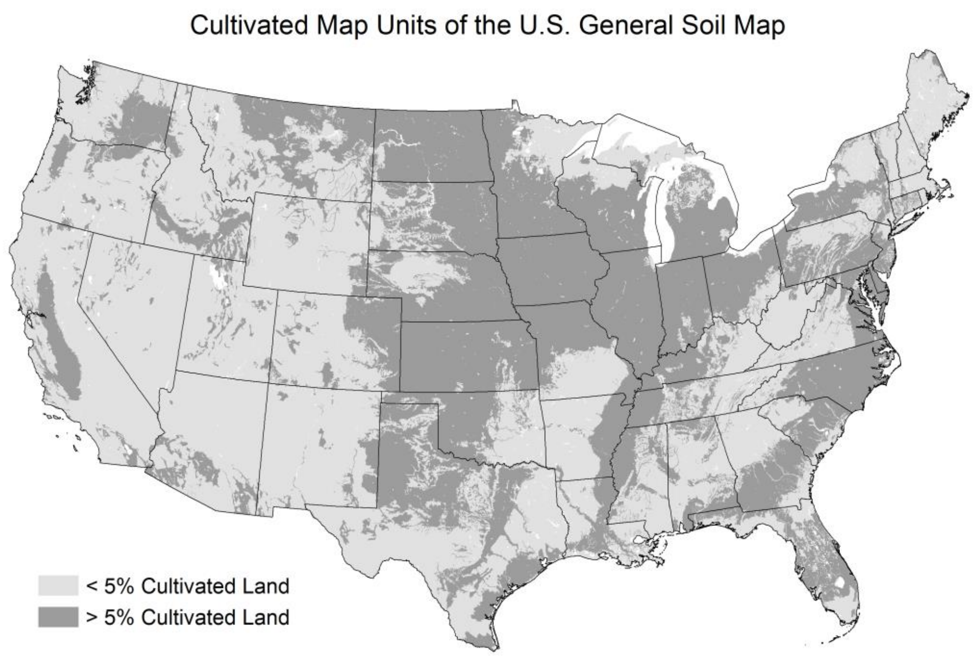

Figure 3.3. Eligible Areas of the U.S. General Soil Map Based on Existing Crop Cultivation

[14] Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed 12/18/2014.
[15] USDA National Agricultural Statistics Service Cropland Data Layer. 2013. Published crop-specific data layer [Online]. Available at http://nassgeodata.gmu.edu/CropScape/ (accessed 1/24/2014). USDA-NASS, Washington, DC.
[16] The GIS shapefile is available at: http://www.climateactionreserve.org/how/protocols/grassland/.

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 involved two parts to ensure the project activity is allowed but not compelled:

1. There must be no federal, state, or local regulation, or other legally binding mandate, agreement, contract[17], deed restriction or deeded encumbrance[18], either pre-existing or subsequent (other than the easement that is enacted for the project), for the project area to be maintained as grassland; and,
2. There must be no zoning, permitting, ownership, or other legal obstacle to the conversion of the project area to cropland.

Voluntary agreements that can be rescinded, such as rental contracts, are not considered legal requirements.

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. Agreements of this nature that are approved up to 6 months before to the project's start date and that satisfy Section 3.3.2.1 are not considered pre-existing legally binding agreements for the purpose of the Legal Requirement Test.[19]

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, such that there may be multiple Grassland Owners within the Project Area. Deeded encumbrances are considered legally binding mandates for the purposes of the Legal Requirement Test.

To satisfy the Legal Requirement Test, the Project Operator must submit a signed Attestation of Voluntary Implementation form[20] prior to the commencement of 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.

[17] 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.
[18] Unless all parties with a potential claim to soil carbon ownership participate in the project as Grassland Owners, per Section 3.2, any encumbrance or restriction or any other recorded agreement, either pre-existing or subsequent to the project start date, 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 Operator(s) to undertake a soil carbon offset project on the project area. See Section 3.6 Project Implementation Agreement and 3.7 Use of Qualified Conservation Easements or Qualified Deed Restrictions for more information on eligibility requirements regarding title recordings and encumbrances.
[19] 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 3.3.3.3.
[20] Attestation forms are available at http://www.climateactionreserve.org/how/program/documents/.

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 or 3.3.3, under the following conditions.

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, it is referred to as "credit stacking" or "payment stacking," respectively.[21] 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 Operator 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.[22] 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)[23]. The

[21] Cooley, D., & Olander, L., September 2011.
[22] U.S. Fish and Wildlife Service. Guidance for the Establishment, Use and Operation of Conservation Banks (2003).
[23] 16 USC Section 1539 (2009).

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.[24] It is thus reasonable to assume that FWS 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)[25] may issue a Department of Army (DA) permit to authorize such actions subject to the creation of a wetland mitigation bank.[26] 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.[27] 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

[24] Ibid.
[25] 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
[26] 33 CFR 332
[27] 33 CFR 332.3(h)(1)(v) .

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.[28] 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,[29] but does not provide any additional guidance on ensuring the environmental benefit of any payment for ecosystem service stacked with an NRCS payment.

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. 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

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.

[28] 33 CFR 332.3 (j)(1)(ii).
[29] EQIP, 7 CFR §1466.36; CSP, 7 CFR §1470.37.

Because every available landscape-scale payment is not comprehensively addressed by the protocol at this time, the Project Operator must disclose any such payments to the verifier and the Reserve on an ongoing basis.

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 Operator 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 assumed to be 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. 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 7.3. 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.[30]

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

3.5 Requirements for Permanence

Project Operators 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. For example, if CRTs are issued to a grassland project in year 24 following its start date, monitoring and verification activities must be continued through at least year 124. Timing of monitoring, reporting, and verification activities is described in more detail in Sections 6, 7, and 8.

There are three possible exceptions to this minimum time commitment:

1. A grassland project automatically terminates if a natural disturbance occurs,[31] leading to a reversal that affects the entire project area. In such a case the Reserve will retire a quantity of CRTs from the grassland buffer pool equal to the quantity of CRTs which have been issued for that project. All future crediting for that project will cease and the project will be terminated.
2. A grassland project may be voluntarily terminated prior to the end of its minimum time commitment if the Project Operator retires a quantity of CRTs, as specified in Section 3.5.1 below.
3. A grassland project may be automatically terminated if there is a breach of certain terms described within the PIA. Such a termination will require the Project Operator to retire a quantity of CRTs, as specified in Section 3.5.1 below.

3.5.1 Retiring CRTs Following Project Termination

If a project is terminated for any reason other than a natural disturbance, the Project Operator must transfer to the Reserve a quantity of CRTs from its Reserve account equal to the total number of CRTs issued to the project for the acres which are being terminated (see Equation 5.14 for quantification guidance). The retired CRTs must be those that were issued to the grassland project, or that were issued to other grassland projects registered with the Reserve. If sufficient grassland CRTs do not exist, or are not available, CRTs issued to Reserve forest projects are acceptable.

The Reserve will retire the CRTs and they will be designated in the Reserve's software system as compensating for a grassland reversal.

3.5.2 Terminating a Portion of the Project Area

There may be cases where a Project Operator wishes to terminate only a portion of the project, either for voluntary reasons or due to a natural disturbance which is not significant enough to terminate the entire project. In that case, the project developer will determine the quantity of CRTs which have been issued for the area to be removed by following the quantification guidance in Equation 5.14.

3.5.3 Project Implementation Agreement

For a grassland project to be eligible for registration with the Reserve, the Project Operator is required to enter into a Project Implementation Agreement (PIA) with the Reserve.[32] The PIA is

[31] The natural disturbance shall not be the result of intentional or grossly negligent acts of any of the Project Operator.
[32] 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/.

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

3.6 Regulatory Compliance

As a final eligibility requirement, Project Operators 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[33] prior to the commencement of verification activities each time the project is verified. Project developers are also required to disclose in writing to the verifier any and all instances of legal violations – material or otherwise – caused by the project activities.

A violation 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. Individual violations due to administrative or reporting issues, or due to "acts of nature," are not considered material and will not affect CRT crediting. However, recurrent administrative violations directly related to project activities may affect crediting. Verifiers must determine if recurrent violations rise to the level of materiality. If the verifier is unable to assess the materiality of the violation, then the verifier shall consult with the Reserve.

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

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.[34] 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.

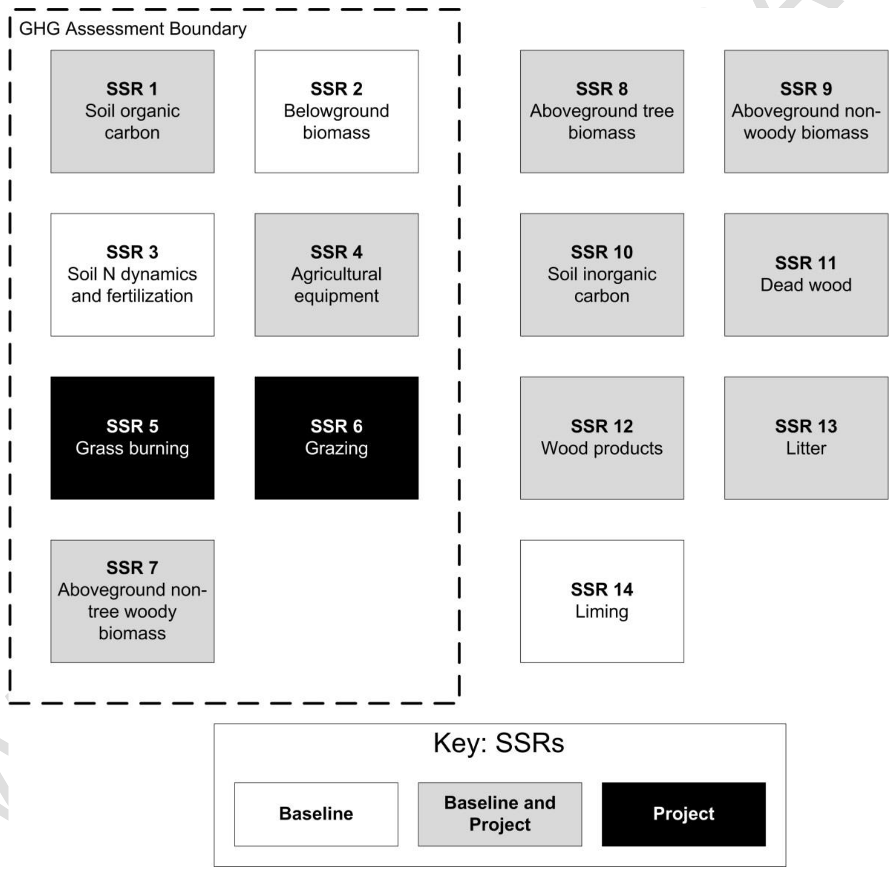

Figure 4.1. General Illustration of the GHG Assessment Boundary

[34] 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.
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.
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. 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	Grass 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 non-tree woody biomass	CO_2	O	Field measurement and quantification	Emissions from the loss of above-ground woody biomass can be a significant emission source in the baseline for certain projects. Exclusion would be conservative. If these emissions are counted in the baseline, then this pool must be monitored for reversals.
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.

SSR	Source Description	Gas	Included (I), Optional (O), or Excluded (E)	Quantification Method	Justification/Explanation
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.
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[35] treat liming as an emission source, whereas current USDA quantification methodologies[36] treat it as a net sink.

[35] IPCC (2006), 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4: Agriculture, Forestry and Other Land Use, Chapter 11: N2O Emissions from Managed Soils and CO2 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
[36] 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 soil 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).

Timelines for quantifying and reporting GHG emission reductions are detailed in Section 7.3. 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 7.3).

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.[37] 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.

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.

If a particular unit of time measurement is not specified for a parameter or result which logically applies to a certain period of time, then that parameter or result shall be assumed to apply to the entire reporting period.

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

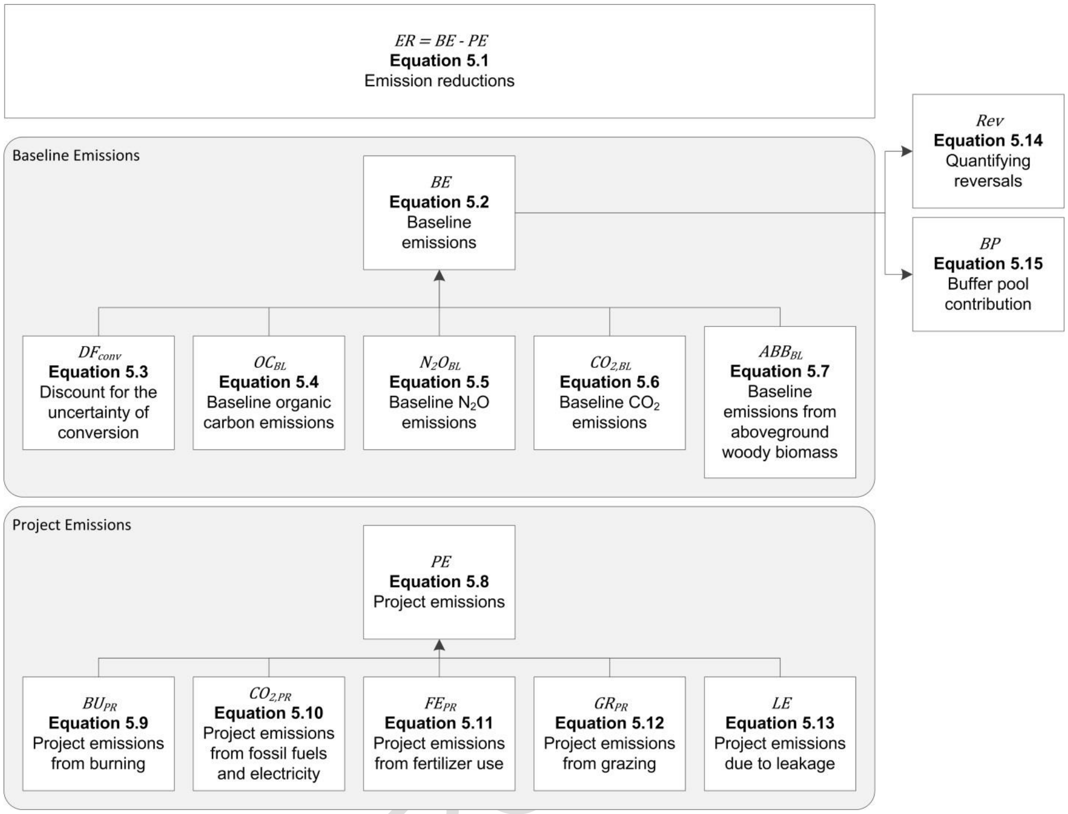

Figure 5.1. Organization of Quantification for Grassland Projects

Equation 5.1. GHG Emission Reductions

$$ER = BE - PE$$

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 calculating acreage in each stratum are provided in Section 5.1.5. All calculations shall be performed at the stratum level.

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.[38] 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.[39] 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.

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.[40] 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)

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.

[38] 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.

[39] 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.

[40] 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.

For pre-project years when the Cropland Data Layer (CDL)[41] data are available (back to 2008 for all states, earlier for a subset of states), the project area shall be assessed against this resource for each year that data are available to confirm that the land use identified in all prior years is the same as that of the year prior to the project start date.

For years when the CDL is not available, projects may demonstrate the pre-project land use through one or more of the following options, subject to acceptance by the project verifier:

1. Contract(s) covering the relevant year(s) whose terms would prevent conversion from grassland, but that would not cause the project to fail the Legal Requirement Test (e.g., grazing leases or haying contracts).
2. Time-referenced photos of the project area taken during the relevant year(s)
3. Time-referenced aerial photos taken during the relevant year(s)
4. Tax records that indicate the land use during the relevant year(s)
5. Notarized affidavit(s) from unrelated and unaffiliated parties attesting that the land use in the relevant year(s) was the same as the year prior to the project start date
6. Notarized affidavit from the Grassland Owner(s) attesting that the land use in the relevant year(s) was the same as the year prior to the project start date
7. Other official records submitted to or generated by a government agency that would indicate the land use or management during the relevant year(s)
8. A combination of the above options that, in aggregate, provide temporal coverage for the entire pre-project time period (either 10 years or 30 years, depending on the assertion)

The above list is not meant to be comprehensive. The project developer may employ alternative approaches to monitoring pre-project land use, 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.

5.1.4 Results of Stratification

In total, this protocol stratifies the U.S. into 1,674 unique strata based on the three variables previously discussed. Box 5.1 describes the method for naming each individual stratum.

Box 5.1. Stratum Naming Convention

Name format: **X_Y_Z**

Where,		<u>Range of Values</u>
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:

[41] 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/.

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

5.1.5 Determining Project Area in Each Stratum

All 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 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.

In order 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,[42] which is a user-friendly tool for accessing data from the Soil Survey Geographic Database (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 of each SSURGO map unit within the project area.

Through the WSS application, the user may zoom in on 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 also possible to use a previously-created shapefile to define the AOI, which ensures that the project boundaries are consistently defined). After 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 5.2.

Table 5.2. Soil Texture Categorization

SSURGO Texture Class	Grassland Protocol Texture Group
Sand	Sand
Loamy sand	Sand
Sandy loam	Sand

[42] This web application is available at: http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx.

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).

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. For the initial reporting period, projects will apply the emission factors in the “Year 1-10” group. Those factors will continue to be used for quantification until reporting reaches January 1st of the calendar year that is 10 greater than the calendar year of the project start date (e.g. if the project begins on May 9, 2015, the “Year 1-10” emission factors will be used for reporting through December 31, 2024, and the “Year 11-20” emission factors will begin to be employed for reporting as of January 1, 2025).

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:

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

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

Equation 5.2. Baseline Emissions

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

Where,			Units
BE	=	Total baseline emissions for the reporting period	tCO_2e
OC_{BL}	=	Baseline emissions due to loss of organic carbon in soil and biomass (Equation 5.4)	tCO_2e

N_2O_{BL}	=	Baseline emissions of nitrous oxide (Equation 5.5)	tCO_2e
$CO_{2,BL}$	=	Baseline CO_2 emissions due to fossil fuel combustion and electricity usage (Equation 5.6)	tCO_2e
ABB_{BL}	=	Baseline emissions due to the loss of above-ground woody biomass (Equation 5.7) (optional)	tCO_2e
DF_{conv}	=	Discount factor for the uncertainty of baseline conversion (Equation 5.3)	%
DF_σ	=	Discount factor for the uncertainty of modeling future management practices and climatic conditions (Table 5.3)	%
Pro	=	Pro-rating factor (see Box 5.2)	%

5.2.1 Discount Factors

There are two discount factors that are applicable to the quantification of baseline emissions, DF_{conv} and DF_σ. The former 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 5.3 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[8]). In
Equation 5.2, this discount is applied to the entire estimate of baseline emissions.

Equation 5.3 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	=	The cropland premium for the county where the project is located	(\$/ac) or (%)
FT_l	=	The lower threshold for financial additionality (Section 3.3.1.2)	(\$/ac) or (%)
FT_u	=	The upper threshold for financial additionality (Section 3.3.1.2)	(\$/ac) or (%)
50%	=	The maximum value of DF_{conv}	

The second discount factor 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 emissions is discounted according to Table 5.3 to account for this uncertainty, with the discount increasing through time in accordance with increasing uncertainty. 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.

Table 5.3. Discount Factor for the Uncertainty of Modeling Future Practices and Climate

Reporting Year	2015-2019	2020-2024	2025-2029	2030-2034	2035-2039
Discount Factor (DF_σ)	1%	2%	3%	4%	5%

5.2.2 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. This loss is greatest in the period of time immediately following the conversion, mostly due to the initial tilling, but can continue for decades after the land use change occurs. 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 development of the emission factors used in this quantification and the companion tables for the baseline emission factors.

Equation 5.4. Baseline Organic Carbon Emissions from Soil and Biomass Loss

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

Where,			Units
OC_{BL}	=	Baseline quantity of organic carbon emissions from soil and 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,[43] 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

5.2.3 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.[44] Using emission factors developed with the composite modeling approach described in Appendix B, baseline emissions of N_2O are estimated for each stratum.

Equation 5.5. Baseline Emissions of N_2O

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

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,[43] selecting the appropriate stratum and time category)	kg N_2O/ac/yr

[43] All stratum and county level information is contained in a separate document, "Grassland Parameters by Strata and Counties," available at: http://www.climateactionreserve.org/how/protocols/grassland/.
[44] 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/.

$Area_s$	=	Area of the project in stratum *s*	acres
GWP_{N2O}	=	The 100-year global warming potential of N_2O (refer to Table 5.1).	CO_2e/N_2O
1000	=	Conversion factor	kg/t

5.2.4 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 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[45]), then those projects may not claim emission reductions for this source, and must use a value of zero for $CO_{2,BL}$.

Equation 5.6. Baseline CO_2 Emissions from Fossil Fuel

$$\boldsymbol{CO_{2,BL}} = \sum_{s}^{S}\left(\boldsymbol{BEF_{CO_2,s}} \times \frac{\boldsymbol{EF_{FF}}}{\mathbf{1000}} \times \boldsymbol{Area_s}\right)$$

Where, Units

$CO_{2,BL}$	=	Baseline emissions due to fossil fuel combustion	tCO_2e
$BEF_{CO2,s}$	=	Annual baseline emission factor for carbon dioxide emissions from fossil fuel combustion for stratum *s* (refer to companion tables,[8] selecting the appropriate stratum and time category)	gal/ac/yr
EF_{FF}	=	Emission factor for diesel (distillate fuel #2) from Table C.1	kg CO_2/gal
1000	=	Conversion factor	kg/t
Area	=	Area of project	acres

5.2.5 Baseline Emissions from Aboveground Woody Biomass (Optional)

Some grassland areas may contain a significant quantity of woody biomass 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).

Equation 5.7. Baseline Emissions from Aboveground Woody Biomass (Optional)

$$\boldsymbol{ABB_{BL,y}} = \boldsymbol{AWB_{y=0}} \times \boldsymbol{e}^{\left(-\mathbf{0.77}\times(\boldsymbol{t}-\mathbf{1})\right)} - \boldsymbol{AWB_{y=0}} \times \boldsymbol{e}^{(-\mathbf{0.77}\times\boldsymbol{t})}$$

Where, Units

$ABB_{BL,y}$	=	Baseline emissions due to the loss of aboveground woody biomass in the current project reporting year	tCO_2e

[45] Additional information regarding the California cap-and-trade program is available at: http://www.arb.ca.gov/cc/capandtrade/capandtrade.htm.

$AWB_{y=0}$	= Aboveground woody biomass at project initiation as determined below	tCO_2e
0.77	= Decay rate, based on leaf decomposition in no-till cropland (Kochsiek, 2009)	
t	= Time since start date	years

$$AWB_{y=0} = Area_{AWB} \times \sum_{WB}\left(\frac{DM_{wb}}{1000} \times CF_{wb} \times \frac{44}{12} \times Frac_{wb}\right)$$

Where,		Units
WB	= Total number of types of aboveground woody biomass to be quantified	
wb	= Individual type of aboveground woody biomass	
DM_{wb}	= Dry matter for aboveground woody biomass type w*b* (additional guidance in Section 6.4)	kg/ac
1000	= Conversion factor	kg/t
CF_{wb}	= Carbon fraction of aboveground woody 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
$Frac_{wb}$	= Fraction of total aboveground woody biomass area coverage represented by woody biomass type w*b* (refer to Section 6.4)	%
$Area_{AWB}$	= Area of aboveground woody biomass canopy coverage	acres

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*,[46] this protocol specifically allows for the project developer to use an alternative estimation methodology.

Equation 5.8. Project Emissions

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

Where,		Units
PE	= Project emissions	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 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

[46] 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/.

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 woody biomass, the CO_2 emissions from that material must be subtracted. The project emissions of CH_4 and N_2O must be estimated using Equation 5.9.

Equation 5.9 Project Emissions from Grass Burning

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

Where,			Units
BU_{PR}	=	Emissions from burning in the project scenario	tCO_2e
$Area_{burn,s}$	=	Area of stratum *s* that was burned	acres
DM_s	=	Amount of aboveground dry matter for non-woody biomass in stratum *s* (refer to companion tables,[8] selecting the appropriate stratum and time category)	kg/acre
$DM_{wb,s}$	=	Dry matter for aboveground woody biomass type w*b* in stratum *s* (additional guidance in Section 6.4)	kg/acre
2.3	=	Emission factor for methane from biomass burning[47]	g/kg dry matter
0.21	=	Emission factor for nitrous oxide from biomass burning[47]	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
$ABB_{BL,y-}$	=	Baseline emissions due to the loss of aboveground woody biomass (total for all prior reporting periods)	tCO_2e
$Area_{burn,wb}$	=	Total area burned which contained monitored woody biomass	acres
$Area_{AWB}$	=	Total area with monitored woody 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 $_{FFPR}$ is reasonably expected to be *de minimis* (i.e. less than the relevant materiality threshold[48]), these emissions may be estimated through a conservative method proposed by the project developer and deemed acceptable by the project verifier.

[47] 2006 IPCC Guidelines for Greenhouse Gas Inventories, Chapter 2, Table 2.5.
[48] 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.[49] Projects shall use the annual total output emission rates for the subregion where the project is located	kg CO_2/MWh

5.3.3 Project Emissions from Fertilizer Use

In the case that the project activities include the application of organic fertilizer, the project emissions of N_2O are estimated using Equation 5.10. 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 annual potential evapotranspiration. The Reserve has determined this average for the previous 48 years using precipitation and evaporation data from the National Oceanic and Atmospheric Agency (NOAA). Evaporation values were converted to potential evapotranspiration values using the guidance found in Appendix E of the Reserve's Nitrogen Management Project Protocol V1.1.[50] The results of this analysis are displayed in Figure 5.2 and are contained within the county-level companion tables.[43]

[49] Available online at: http://www.epa.gov/cleanenergy/energy-resources/egrid/
[50] Available at: http://www.climateactionreserve.org/how/protocols/nitrogen-management/.

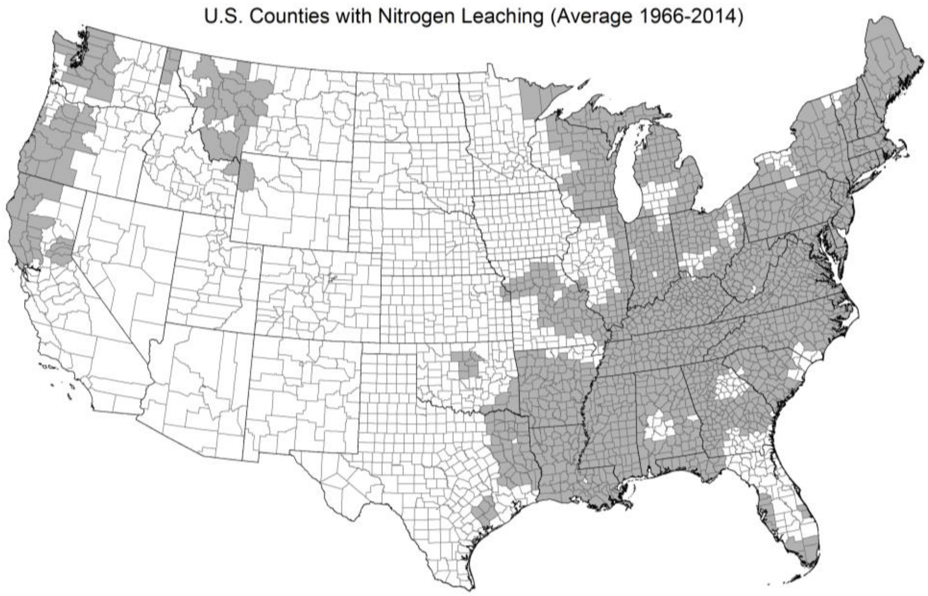

Figure 5.2. U.S. Counties Where Nitrogen Leaching is Expected to Occur, on Average, for 1966-2014

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.[43]	
$\frac{44}{28}$	=	Conversion factor	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, as evidenced in the grazing monitoring data.

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 Days	Animal Grazing Days
Bulls	100	50	5,000
Beef Cows	200	75	15,000
Beef Replacements	40	75	3,000

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.

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.[43]	

$\frac{44}{28}$	=	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 livestock category *l* (Table C.3)	kg VS/animal/day
$B_{0,l}$	=	Maximum methane potential for manure from livestock 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

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

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

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,			Units
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

This protocol allows for crediting of avoided emissions of carbon stored in the grassland soils. For credits to represent valid emissions offsets, the carbon must be maintained in the soil over time and not “reversed” For the purposes of this protocol, an emission reduction based on carbon storage is considered “permanent” when the carbon has been maintained for 100 years following the issuance of the credit. If carbon is released before the end of this period, the release is termed a “reversal.” This protocol considers two categories of reversals, avoidable and unavoidable, and specifies separate remedies for each. Permanence requirements do not apply to emission reductions unrelated to carbon stored in the project area soils (e.g. CH_4 and N_2O). In either case, the amount of the reversal is determined based on the specific acres affected, using Equation 5.14. Following a reversal, the affected acres are no longer eligible for crediting. If the reversal affects the entire project area, the project will be terminated.

Equation 5.14 Quantifying reversals

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

Where,			Units
Rev	=	The quantity of emissions due to the reversal	tCO_2e
Y	=	Total number of years for which CRTs have already been issued	years
$OC_{BL,rev,y}$	=	Baseline emissions due to the loss of organic carbon in soil and biomass in year *y* for the acres affected by the reversal	tCO_2e
DF_{conv}	=	Discount factor for the uncertainty of baseline conversion	
$ABB_{BL,rev,y}$	=	Baseline emissions due to the loss of aboveground woody biomass in year *y* for the acres affected by the reversal	tCO_2e
$DF_{\rho,y}$	=	Discount factor for the uncertainty of modeling future management practices and climatic conditions for year *y*	

5.4.1 Avoidable Reversals

A reversal is considered avoidable when it is not caused by natural forces. Avoidable reversals in the context of a grassland project will likely take the form of a decision to exit the project and convert the project area to cropland. However, it could also occur on smaller scales, such as eminent domain, mining or drilling activities, or installation of wind turbines. Requirements for avoidable reversals are as follows:

1. If an avoidable reversal has been identified during annual monitoring, the Project Operator must give written notice to the Reserve within thirty days of identifying the reversal. Additionally, if the Reserve determines that an avoidable reversal has occurred, it shall deliver written notice to the Project Operator.
2. Within thirty days of receiving the avoidable reversal notice from the Reserve, the Project Operator must provide a written description and explanation of the reversal to the Reserve, including a map of the specific area which is affected.
3. Within four months of receiving the avoidable reversal notice, the Project Operator 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, 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 Unavoidable Reversals

An unavoidable reversal is any reversal not due to eminent domain or the Project Operator's negligence, gross negligence, or willful intent. Requirements for unavoidable reversals are as follows:

1. If the Project Operator determines there has been an unavoidable reversal, it must notify the Reserve in writing of the unavoidable reversal within six months of its occurrence.
2. The Project Operator must explain the nature of the unavoidable reversal, 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 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 Operator will 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 not returned to the project. The buffer pool is shared by all grassland projects, and the quantity of potential credits that a project could receive in the event of an unavoidable reversal is not related to the quantity of credits that project has previously contributed.

It is the understanding of the Reserve that 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. Thus, the Reserve has decided to adopt a standard buffer pool contribution for all projects that is intended to insure against all types of unavoidable reversals. Equation 5.15 shall be used to calculate the buffer pool contribution for the project during the reporting period.

Equation 5.15 Buffer Pool Contribution to Insure Against Unavoidable Reversals

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

Where,			Units
BP	=	Project contribution to the buffer pool	tCO_2e
RUR	=	Risk of unavoidable reversals. All projects shall apply a value of **2%**.	%
OC_{BL}	=	Baseline quantity of organic carbon emissions from soil and biomass (Equation 5.4)	tCO_2e
ABB_{BL}	=	Baseline emissions due to the loss of aboveground woody biomass (Equation 5.7) (Optional – only include if project developer has chosen to quantify as part of baseline emissions)	tCO_2e

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 the methods and frequency of data acquisition; a record keeping plan (see Section 7.2 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 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	Once	Information used to assess satisfaction of the requirements of Section 3

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	Per verification 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 5.4, Equation 5.5	S	Total number of strata relevant to the project area	Strata	R	Once[51]	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 5.6	Area	Area of the entire project	Acres	M	Once[51]	
Equation 5.4, Equation 5.5	$Area_s$	Area of project in stratum *s*	Acres	M	Once[51]	
Baseline Calculation Parameters						
Equation 5.1, Equation 5.2, Equation 5.13	BE	Baseline emissions	tCO_2e	C	Per reporting period	
Equation 5.2, Equation 5.4, Equation 5.15	OC_{BL}	Baseline emissions due to loss of organic carbon	tCO_2e	C	Per reporting period	

[51] 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	N_2O_{BL}	Baseline emissions of nitrous oxide	tCO_2e	C	Per reporting period	
Equation 5.2,Equation 5.6	$CO_{2,BL}$	Baseline emissions of carbon dioxide	tCO_2e	C	Per reporting period	
Equation 5.2 Equation 5.7,Equation 5.15	ABB_{BL}	Baseline emissions due to loss of above-ground woody biomass	tCO_2e	C	Per reporting period	
Equation 5.2, Equation 5.3, Equation 5.14	DF_{conv}	Discount factor for the uncertainty of conversion	%	R	Once	
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	
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	($/ac) or (%)	R	Once	The cropland premium for the project site county may be referenced from the companion tables[52]
Equation 5.3	FT_l	Lower threshold for financial additionality	($/ac) or (%)	R	Once	The financial thresholds for additionality can be found in Section 3.3.1.2.
Equation 5.3	FT_u	Upper threshold for financial additionality	($/ac) or (%)	R	Once	

[52] All stratum and county level information is contained in a separate document, "Grassland Parameters by Strata and Counties," 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 5.4	$BEF_{OC,s,y}$	Annual baseline emission factor for organic carbon	kg CO_2e/ac/yr	R	Per reporting period	
Equation 5.5	$BEF_{N2O,s}$	Annual baseline emission factor for N_2O emissions in stratum *s*	kg N_2O/ac/yr	R	Per reporting period	
Equation 5.6	BEF_{CO2}	Annual baseline emission factor for CO_2 emission from fossil fuel combustion	gal/ac/yr	R	Per reporting period	
Equation 5.6	EF_{FF}	Emission factor for diesel fuel	kg CO_2/gal	R	Per reporting period	
Equation 5.7	$AWB_{y=0}$	Quantity of aboveground woody biomass at project initiation	tCO_2e	C	Once	
Equation 5.7	*t*	Time since start date	years	C	Per reporting period	The number of years counting from the start date, in whole numbers
Equation 5.7	WB	Types of aboveground biomass	N/A	M	Once	
Equation 5.7	DM_{wb}	Dry matter contained in biomass type w*b*	t/ac	R	Once	
Equation 5.7	CF_{wb}	Carbon fraction of biomass type w*b*	t C/t biomass	R	Once	
Equation 5.7	$Frac_b$	Fraction of total aboveground woody biomass area coverage represented by biomass type *b*	%	M	Once	
Equation 5.7	$Area_{AWB}$	Area of aboveground woody biomass canopy coverage	Acres	M	Once[51]	
Project Calculation Parameters						
Equation 5.8	PE	Project emissions	tCO_2e	C	Per reporting period	
Equation 5.8, Equation 5.9	BU_{PR}	Emissions from burning in the project scenario	tCO_2e	C	Per 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	

Eq. #	Parameter	Description	Data Unit	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comment
Equation 5.8, Equation 5.11	FE_{PR}	Emissions from fertilizer use in the project scenario	tCO_2e	C	Per reporting period	
Equation 5.8, Equation 5.12	GR_{PR}	Emissions from livestock grazing in the project scenario	tCO_2e	C	Per reporting period	
Equation 5.8	LE	Emissions from leakage in the project scenario	tCO_2e	C	Per reporting period	
Equation 5.9	$Area_{burn,s}$	Area of stratum *s* that was burned	Acres	O	Per fire event	
Equation 5.9	DM_s	Amount of aboveground dry matter in stratum *s*	kg/ac	R	Per reporting period	
Equation 5.9	$DM_{wb,s}$	Amount of aboveground dry matter in woody biomass type *wb* in stratum *s*	kg/ac	R	Per fire event	
Equation 5.9	$ABB_{BL,y-}$	Total baseline emissions due to loss of aboveground woody biomass for all previous reporting periods	tCO_2e	O	Per fire event	
Equation 5.9	$Area_{burn,wb}$	The area that was burned which contained monitored woody biomass	acres	O	Per fire event	
Equation 5.10	QF_f	Quantity of fossil fuel type *f* consumed	volume	O	Per reporting period	
Equation 5.10	$PEF_{FF,f}$	Project emission factor for fossil fuel type *f*	$kgCO_2$/volume fuel	R	Per reporting period	
Equation 5.10	QE	Quantity of electricity consumed during the reporting period	MWh	O	Per reporting period	

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.[53] 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	
Equation 5.11	QF_{PR}	Quantity of organic fertilizer type *c* applied	Kg	O	Per reporting period	
Equation 5.11	NC_c	Nitrogen content of fertilizer type *c*	kg n/kg fertilizer	O	Per 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	
Equation 5.12	N_2O_{MN}	N_2O emissions from livestock grazing	tCO_2e	C	Per reporting period	
Equation 5.12	$CH_{4,MN}$	CH_4 emissions from manure	tCO_2e	C	Per reporting period	
Equation 5.12	$CH_{4,ENT}$	CH_4 emissions from enteric fermentation	tCO_2e	C	Per reporting period	
Equation 5.12	L	Total number of livestock categories	Categories	O	Per reporting period	
Equation 5.12	AGD_l	Animal grazing days for livestock category *l*	Animal days	O	Per reporting period	

[53] 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	Nex_l	Nitrogen excreted by animals in livestock category *l*	kg N/animal grazing day	R	Per reporting period	
Equation 5.12	VS_l	Volatile solids excreted by animals in livestock category *l*	kg VS/animal grazing day	R	Per reporting period	
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	
Equation 5.12	MCF_{PRP}	CH_4 conversion factor for pasture/range/paddock manure management	%	R	Per reporting period	
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	
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	
Equation 5.13	LE	Emissions from leakage	tCO_2e	C	Per reporting period	
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 woody 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	$OC_{BL,rev,y}$	Baseline emissions of organic carbon in soil and biomass in year *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

Eq. #	Parameter	Description	Data Unit	Calculated (C) Measured (M) Reference (R) Operating Records (O)	Measurement Frequency	Comment
Equation 5.14	$ABB_{BL,rev,y}$	Baseline emissions of organic carbon in aboveground woody biomass in year *y* for the acres affected by the reversal	tCO_2e	C	Per reversal event	The quantity of CRTs related to aboveground woody organic carbon affected by the reversal (if claimed in the baseline)
Equation 5.15	BP	Buffer pool contribution	tCO_2e	C	Per reporting period	
Equation 5.15	RUR	Risk of unavoidable reversals	%	R	Once	

6.2 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, this demonstration consists of two required components:

1. **Annual review of Cropland Data Layer**
   The National Agricultural Statistics Service publishes a remote sensing product each year known as the Cropland Data Layer. This product uses satellite imagery to categorize land use across the conterminous U.S. Data collection is focused on the growing season each year in order to accurately categorize different crop types. These data are publicly released each year, usually in February. Projects must overlay the project area boundary on the CDL for the reporting year and identify that the project area continues to be identified in the same land use category as the year prior to the project start date.

2. **Supplemental demonstration of eligible land use**
   In addition to the annual review of the CDL data for the project area, the project developer must provide one additional form of documentation of the continued conservation of the grassland cover in the project area. Possible forms of demonstration include, but are not limited to the items listed in Section 5.1.3. The evidence provided to satisfy this requirement must be sufficient to provide reasonable assurance as to the nature of the land use during the reporting period.

6.3 Monitoring Grazing

Livestock grazing is allowed in the project scenario. While low to moderate levels of grazing may have a beneficial effect on the grassland ecosystem and net soil carbon storage, overgrazing can be detrimental to both the storage of soil carbon and the health of the grassland ecosystem. Project grazing must be limited to moderate levels of intensity. This is ensured through a combination of mechanisms:

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

6.3.1 Prescribed Grazing Management Plan

If there are no legal limitations on grazing intensity (Section 6.3.2), the Project Operator 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.[54] 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[55] or the American Forage and Grassland Council.[56] 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.

6.3.2 Legal Limitations on Grazing Intensity

If the project area is subject to legal limits on grazing intensity, with some mechanism for ongoing monitoring and enforcement, the project is not required to develop and implement a prescribed grazing management plan. The conservation easement put into place for the project may contain language specifically limiting livestock grazing to moderate intensity levels. Overgrazing will be considered a violation of the terms of the easement, determined through ongoing monitoring, and subject to legal enforcement. However, Project Operators are still encouraged to voluntarily implement a prescribed grazing management plan to protect the soil carbon storage in the project area.

6.3.3 Monitoring of Grazing Activities during the Reporting Period

All grazing activities must be monitored and documented for the reporting period. For each reporting period, Project Operators must document the type of livestock being grazed and the total animal grazing days for each type(see Box 5.2). The livestock shall be categorized according to Table C.3. These data are used for the parameter AGD_l in Equation 5.12.

6.4 Monitoring Woody Biomass

For projects that choose to quantify the emission reductions due to avoided loss of non-tree woody biomass in the baseline scenario (Equation 5.7), 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.

[54] Available at http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_025729.pdf.
[55] www.rangelands.org
[56] www.afgc.org

To determine the initial pool of non-tree woody 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.[57] 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 sampling guidance in Section 2.2 of the Urban Forest Management guidance. However, as these plants are expected to 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 determining the carbon-to-canopy ratio of individual plants from either a government agency publication or a peer-reviewed scientific publication.

Comment [MD3]: Workgroup members, if you have specific expertise in this area, please provide feedback or suggestions.

6.5 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)

6.6 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.

[57] Climate Action Reserve, *Quantification Guidance for Urban Forest Management Projects*. June 2014. Available from http://www.climateactionreserve.org/how/protocols/urban-forest/.

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. Project developers must submit verified emission reduction reports to the Reserve annually at a minimum.

7.1 Project Documentation

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

- Project Submittal form
- 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

Project developers must provide the following documentation each verification 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)

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/.

7.2 Record Keeping

For purposes of independent verification and historical documentation, project developers are required to keep all information outlined in this protocol for a period of 10 years after the information is generated or 7 years after the last verification. This information 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 6.2)
- 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
- 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

7.3 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. CRTs will not be issued for reporting periods that have not been verified. Project developers may choose to verify more frequently than every six years.

To meet the verification deadline, the project developer must have the required verification documentation (see Section 7.1) 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.

7.3.1 Site Visit Verification Schedule

When a site visit is required for the verification of a grassland project, the site visit may occur during the verification period or after it is concluded. For projects which are not participating in a cooperative, a site visit verification is required for the initial verification period. For all subsequent verification periods, a desk review verification is sufficient, although a site visit may be conducted at the discretion of the verification body. For projects which are participating in a cooperative, every verification is required to include a site visit to three projects or 10% of the total number of the projects in the cooperative (whichever is greater) until such time as every project has been visited at least once. Once that requirement has been met, site visits are not required, although they may be conducted at the discretion of the verification body.

7.3.2 Desk Review Verification

For verifications which do not include a site visit, the verification body will 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.

7.4 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.

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

8.1 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. Documentation related to individual projects shall also be uploaded to each project's account. One set of verification documentation shall be submitted for the entire cooperative, but the project-specific attestations must be executed by the Project Operator 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.

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.

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 within 6 months of the project start date	Once during first verification
Start Date	Recordation of a conservation easement, transfer of the project area to public ownership, or engaging in consulting services for the carbon project	Once during first verification
Location	Conterminous United States and tribal areas	Once during first verification
Performance Standard	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 and the common practice 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 Operator 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 operator uses to gather data and calculate baseline and project emissions.

Verifying emission reduction estimates
The verification body further investigates areas that have the greatest potential for material misstatements and then confirms whether or not material misstatements have occurred. This 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.

Site Visits
For individual projects not participating in a project cooperative, a site visit to the project site is required during the initial verification. 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. Additional site visits are not required during subsequent verifications, although they may be conducted at the verifier's discretion.

For project cooperatives, the initial verification must involve a visit to either three project sites or 10% of the project sites, whichever is greater. The same requirement applies to subsequent verifications until all projects in the cooperative have been visited at least once. Projects are only required to be visited once during the duration of the crediting period. After every project has been visited, no additional site visits are required for subsequent verifications of that cooperative.

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 reductions by reviewing Attestation of Title	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
3.33.4	Verify that project is within its 50 year crediting period	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
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	Yes
3.5.3	Confirm that the Project Operator 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	Yes

Protocol Section	Eligibility Qualification Item	Apply Professional Judgment?
	performing a risk-based assessment to confirm the statements made by the Project Operator in the Attestation of Regulatory Compliance form	
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
5.1	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	Verify that the emission factors are all correctly selected for the relevant parameters, both for baseline emissions and project emissions	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
7.2	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 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.
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).
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.
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.).
Cooperative Developer	The project developer for a project cooperative. The Cooperative Developer may or may not be one of the project operators participating in the project cooperative.
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 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 project operator.
Project Operator	A grassland owner who bears the legal and reporting responsibilities of the project activities.
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.
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.

Comment [MD4]: Incomplete

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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 Operator, the project satisfies the criterion of "additionality."[58]

A.1 Components of the Performance Standard Test

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

1. Emission reductions threshold,
2. Financial threshold,
3. Suitability threshold, and
4. Existing baseline practice threshold.

The intent of this multi-faceted 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, the PST does achieve such an outcome.

A.1.1 Emission Reductions Threshold

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

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

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.[59] 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.[60] 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.[61] 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[62], 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.

[59] 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.

[60] 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.

[61] 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.

[62] 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.

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

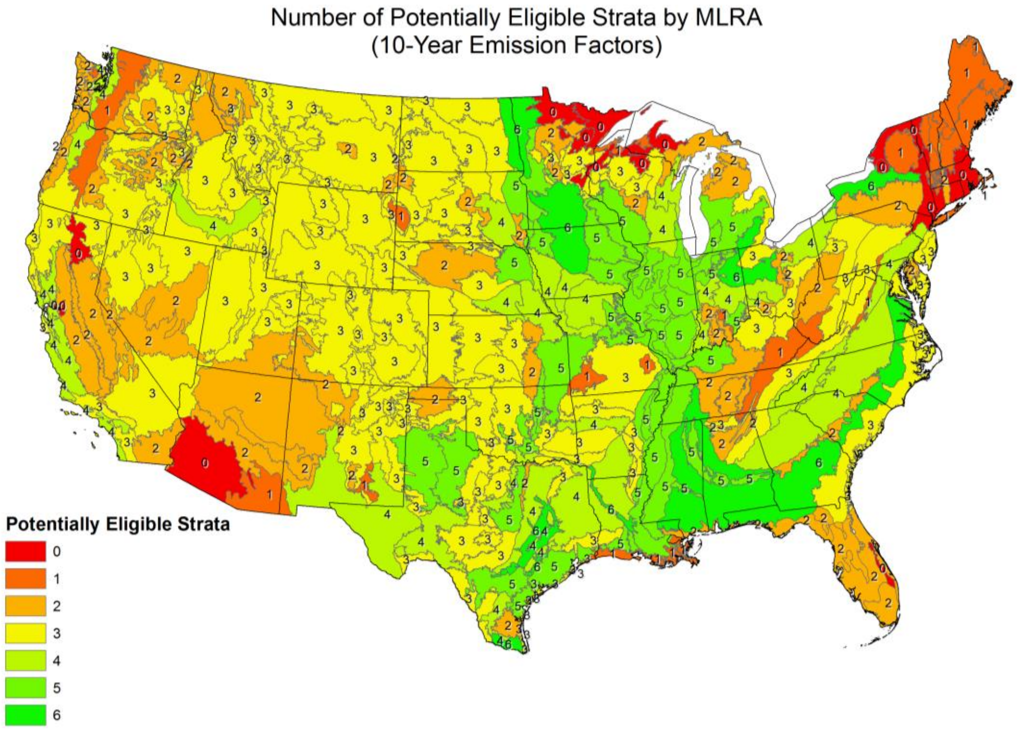

Figure A.1. Potentially Eligible Strata for Each MLRA

A.1.2 Financial Threshold

The second 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[63], 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.[64] The discount represents the uncertainty of the baseline conversion and recognizes that the threshold for the decision to convert will vary between landowners.

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

NOTE TO WORKGROUP

Two different approaches have been proposed for the financial additionality threshold. Where the appendix language is specific to option 1 (the percentage-based threshold), the text is blue. Where the appendix language is specific to option 2 (the $/acre threshold based on conversion rates), the text is green.

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)[65]. 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).

OPTION 1:

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

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

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 5.3.

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.

OPTION 2:
As the rent rate data are available at the county level, the Reserve chose to use this level for the analysis. In order to determine the threshold for the cropland premium, the Reserve attempted to identify the quantitative relationship between the cropland premium and the existing rate of conversion of grassland to cropland. To assist in this analysis, the Reserve received the results of a county-level analysis of conversion rates carried out by The Nature Conservancy. This analysis looked at land use conversions between 2008 and 2012, identifying land which was converted from natural habitat (could include long-term grasslands or fallow cropland) to cultivated cropland, excluding any lands which are not legally available for conversion (public lands, existing easements, etc.). This analysis was carried out to support their work identifying hotspots of conversion activity to help target their conservation efforts.

To compare the conversion rate data with cropland premium data, the Reserve followed the steps outlined in the previous section to calculate average cropland premiums at the county level for the same time period (2008-2012). From the full list of counties, those counties without rent rate data were removed. The 2.5% of counties with the highest and lowest cropland premiums were also removed, leaving 95% of the counties for which cropland premiums were calculated. This was done to help control for the effects of outliers. A total of 2,389 counties were included in the analysis. The conversion rate was plotted against the cropland premium and a logarithmic trendline was generated: $y = 4.8725\ln(x) - 9.8992$, where y equals the conversion rate of grassland to cropland, and x represents the cropland premium.

Following discussion with the Grassland Workgroup members, the Reserve determined that the lower threshold would be set where the conversion rate reaches 0.5%, representing a reasonably high rate of conversion to cropland, and the upper threshold would be set where the conversion rate reaches 2%, representing a very high rate of conversion to cropland. Using these target conversion rates, and rounding to the nearest $0.50, the Reserve set the thresholds of financial additionality at $8.50 and $11.50. Cropland premiums between these two values are subject to a discount on a sliding scale, following the guidance in Equation 5.3.

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 and Figure A.3). 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/.

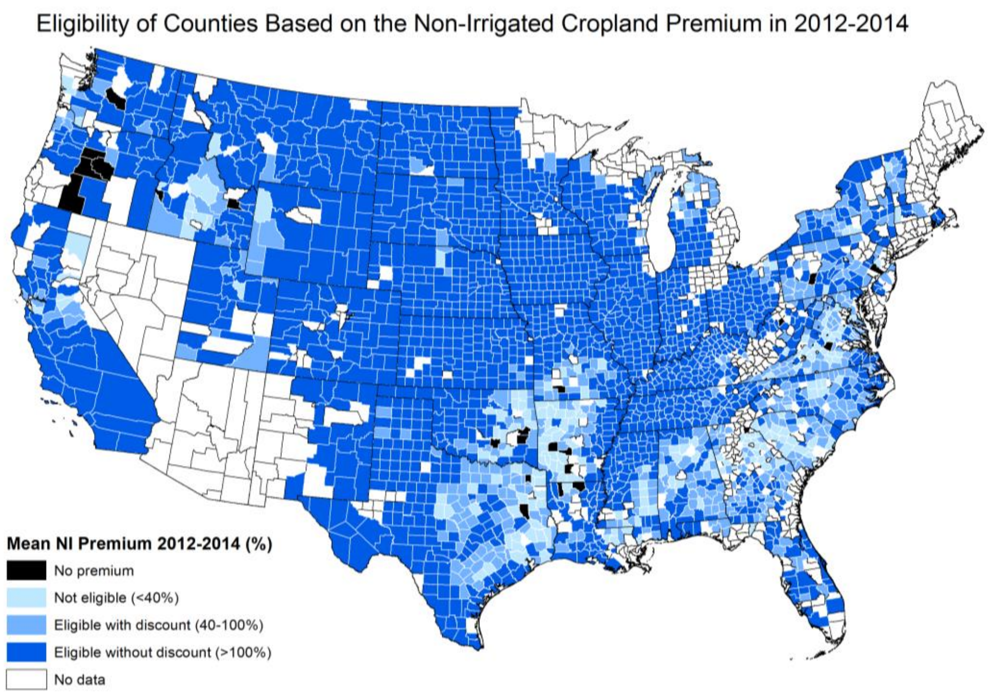

Figure A.2. Eligibility of Counties Based on the Financial Threshold for Additionality (Option 1)

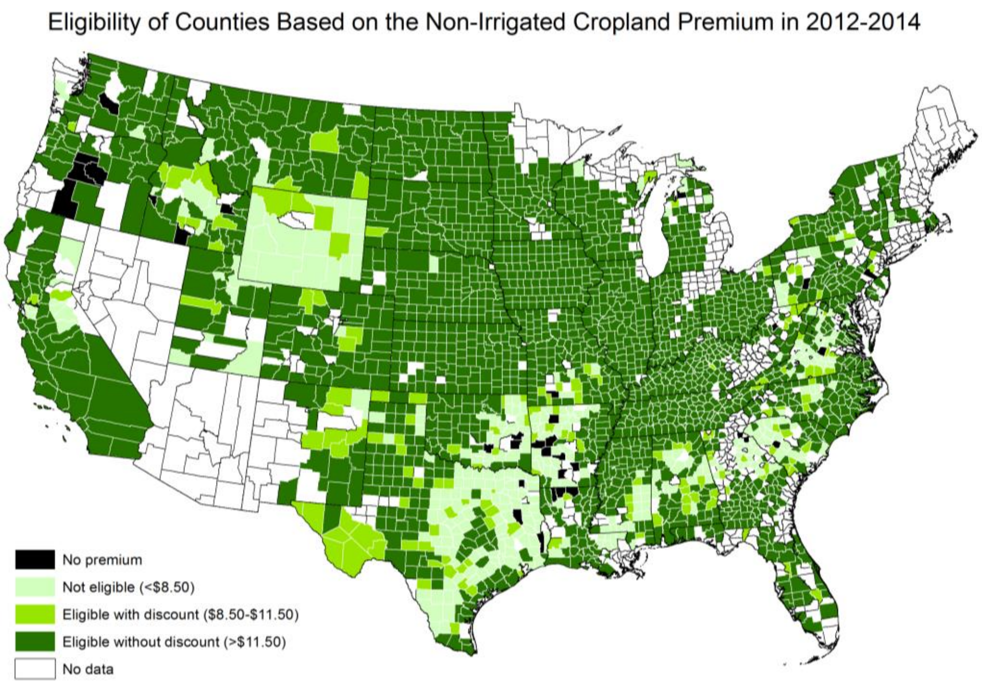

Figure A.3. Eligibility of Counties Based on the Financial Threshold for Additionality (Option 2)

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 third 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[66] 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)

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

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. 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 project area to be Class V or VI.

Determining the LCC for the project area is fairly straightforward using online tools provided by the NRCS (Web Soil Survey).[67] 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 3.3.1.3).

A.1.4 Existing Baseline Practice Threshold

Another proxy for the decision to convert a parcel of land would be the existence of other landowners of similar parcels who have already made that decision. If there are other parcels that share the same climatic characteristics (i.e. same MLRA) and soil type and that have already been converted to crop cultivation, those conversions can serve as reasonable evidence of the existence of pressure to convert the project area to crop cultivation. The Reserve has developed a standardized screen for this test of additionality. Projects must identify their map unit on the Digital General Soil Map of the United States (STATSGO2).[68]

[67] Available at: http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm.
[68] Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed 12/18/2014.

The presence of cultivation was identified using the Cultivated Layer generated from the 2013 Cropland Data Layer, developed by the USDA National Agricultural Statistics Service (Figure A.4).[69]

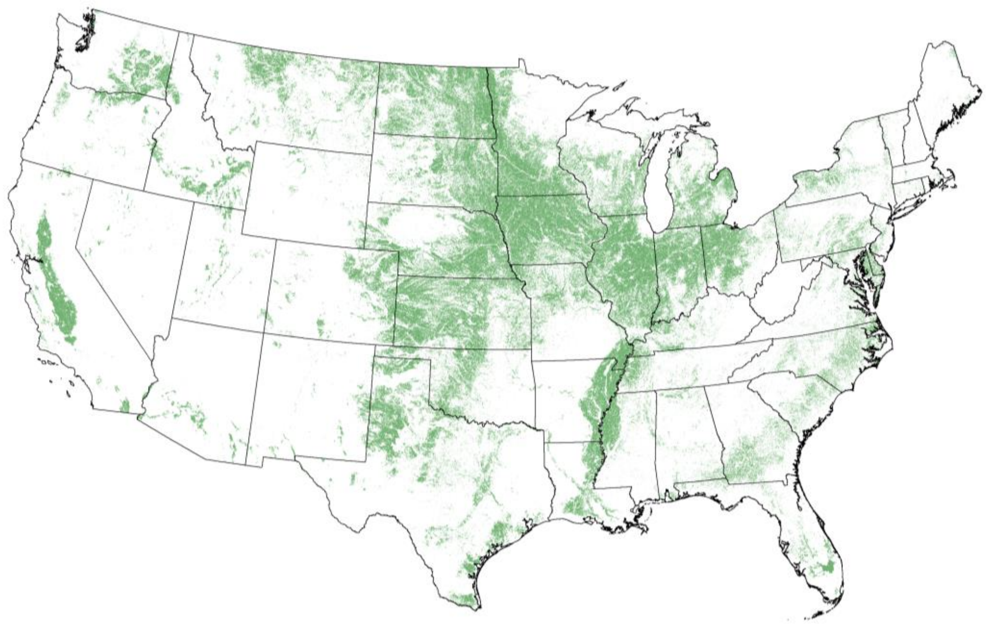

Figure A.4. Cultivated Lands of the Conterminous U.S. (2013)

This map layer was then overlaid with the layer of soil map units, and the cultivated area within each map unit was calculated using ArcGIS. Map units are deemed eligible if at least 5% of the land area is already identified as cultivated. Figure A.5 shows the map units which are eligible based on existing crop cultivation activity. This map is available for download in order for project developers to determine the status of the project area.[70] The Reserve will update this analysis when an updated cultivated layer is made available.

[69] USDA National Agricultural Statistics Service Cropland Data Layer. 2013. Published crop-specific data layer [Online]. Available at http://nassgeodata.gmu.edu/CropScape/ (accessed 1/24/2014). USDA-NASS, Washington, DC.
[70] The GIS shapefile is available at: http://www.climateactionreserve.org/how/protocols/grassland/.

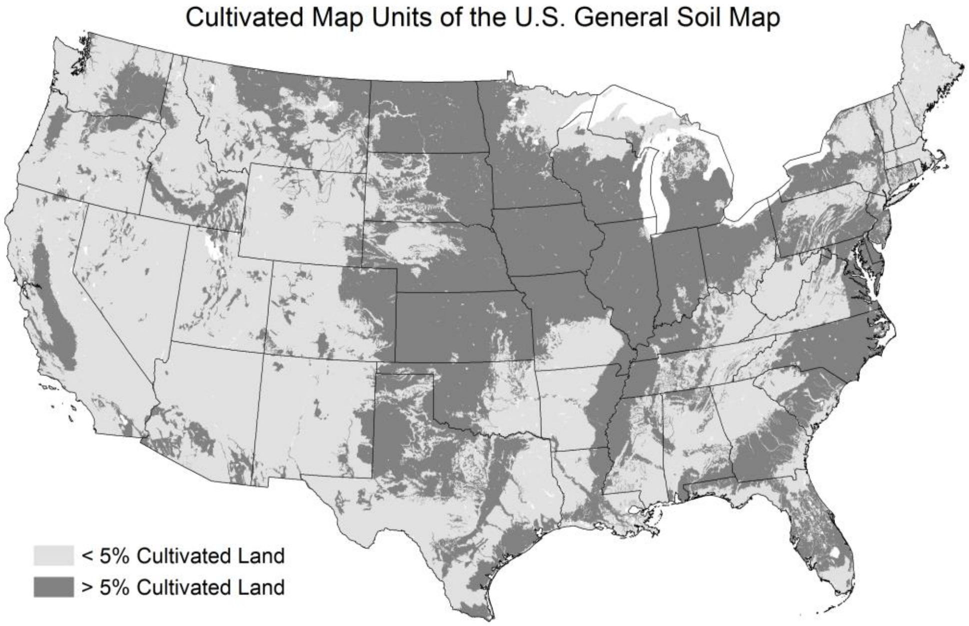

Figure A.5. Eligible Areas of the U.S. General Soil Map Based on Existing Crop Cultivation (map unit boundaries are not shown due to scale)

A.1.5 Complete Performance Standard Test

While none of the individual components of this PST would represent a comprehensive test for additionality on their own, together they function to provide a holistic assessment of the threat of conversion of grassland to cropland in different areas of the country. The figure below illustrates the effect of layering these assessments together. The areas remaining on the map represent areas which may be eligible. Unfortunately the stratification by soil texture and prior land use are almost impossible to represent on a map at this scale. Thus, some areas on the map will only be eligible for certain strata.

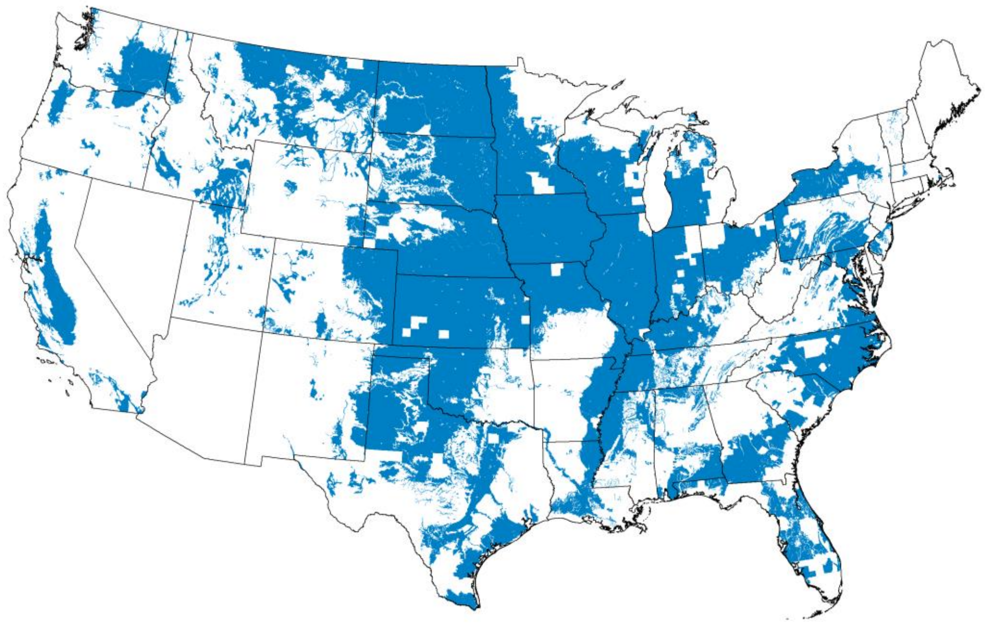

Figure A.6. Potentially Eligible Areas Based on the Complete Performance Standard Test (Option 1)

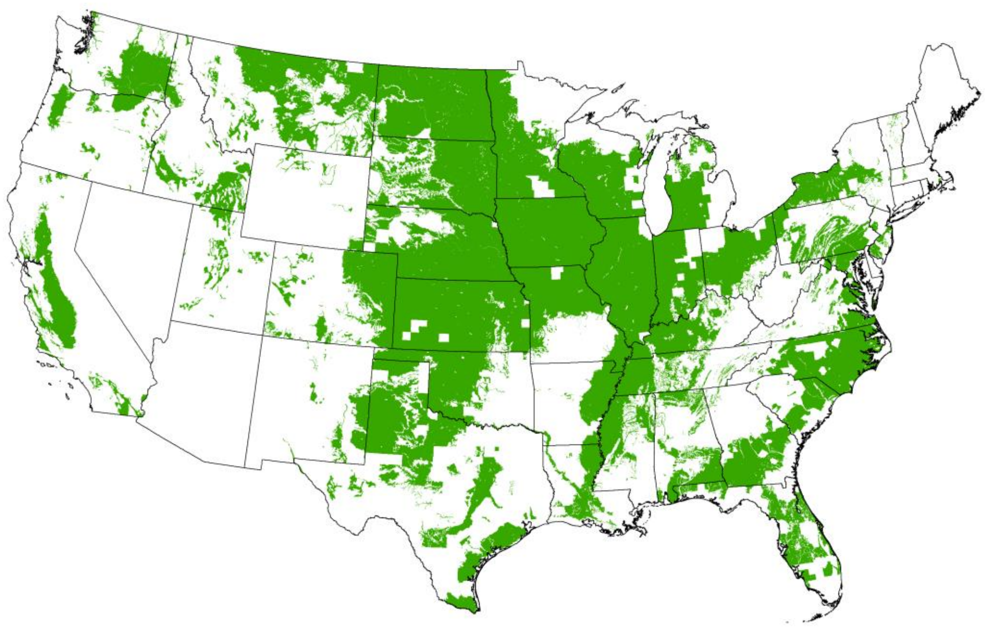

Figure A.7. Potentially Eligible Areas Based on the Complete Performance Standard Test (Option 2)

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.

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[71] (U.S. Inventory) compiled by EPA, and which is incorporated in USDA's entity level GHG quantification tool, COMET-Farm[72]. To compute the emissions associated with baseline conversion scenarios, the contractors utilized DAYCENT model inputs developed for the US Inventory. This includes USDA's Natural Resources Inventory (NRI) as well as ancillary data sets on actual agricultural management practices across the US. 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.

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

[71] 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

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

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 NRI 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 strata 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)[73] – the U.S. was first broken into individual super-strata (unique combinations of these two variables).[74] By first stratifying by MLRA and surface soil texture, the U.S. is effectively subdivided into land areas 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 more 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

[73] Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. *Web Soil Survey*. Available online at http://websoilsurvey.nrcs.usda.gov/
[74] The third variable, previous land use, will be used later in the modeling of baseline emissions.

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[75], 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 USDA National Resource Inventory (NRI), Economic Research Service Cropping Practice Survey (ERS), National Agricultural Statistics Service (NASS), and Natural Resources Conservation Service (NRCS).[76,77,78,79] 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:

- **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 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 NRI points 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.

[75] 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.
[76] 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
[77] 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
[78] USDA-NASS
[79] USDA-NRCS (2012) *Energy Estimator: Tillage*, available at: http://ecat.sc.egov.usda.gov/

- **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, NRI 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[80] and Land Use, Land-Use Change, and Forestry[81] in the U.S. Inventory.

Table B.1. Derivation of Baseline Scenario Input Variables

Baseline Variable	Data Source	Methodology
Tillage practice	NRI, 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 NRI expansion factors.
Typical cropping sequence	NRI, NASS	Assignment of each cropping sequence established using actual NRI data in each super stratum and associated expansion factors, 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.
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	NRI	Irrigated vs. non-irrigated status are specified for each NRI point, 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

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

highly simplified example distribution. Based on the cropping systems established from historic NRI 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 NRI expansion factors to appropriately weight each practice based on its representativeness across the landscape. NRI expansion factors were established during survey design, and are used to indicate the number of acres across the landscape that each NRI sample 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 NRI data point with that practice and its expansion factor (100) being 20% of the aggregate of NRI data points' expansion factors (500) within the super stratum.

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

NRI Data Point	Tillage Practice	Irrigation Practice	Cropping System	Expansion Factor	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).[82] 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 NRI sites 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:

[82] NOAA/OAR/ESRL PSD, *North America Regional Reanalysis Product*, available at: http://www.esrl.noaa.gov/psd/

1. Grassland modeling points were pulled from the NRI data or modified for modeling:
    a. For long term grassland (30+ years), all 154,639 NRI points 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 NRI points 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 NRI point was modeled forward applying the baseline practices determined in Section B.3 through the DAYCENT model for 50 years. The baseline practices for each NRI point were pulled at random without replacement.
4. For the 10-30 year grassland baseline scenario, each NRI point was modeled forward applying the cropping practices associated with that point in the NRI data through the DAYCENT model for 50 years.
5. For the project scenario, each NRI point was modeled forward applying a continuation of the management practices established for the US 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[83]
    b. N_2O emissions (direct and indirect)
7. The extracted emissions in ten year increments were area-weighted based on NRI expansion factors and averaged across points within the strata and translated into average annual per acre emission rates applicable to corresponding ten year increments.

The resulting emission rates are provided by stratum in a tabular form and included as lookup tables[8] 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.

[83] 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.

Finally, fuel consumption was estimated by applying fuel consumption factors from the NRCS Energy Calculator to the practices modeled at each NRI data point. The results from each NRI data point in the baseline scenario were area-weighted based on NRI expansion factors 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 NRI points 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**

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.

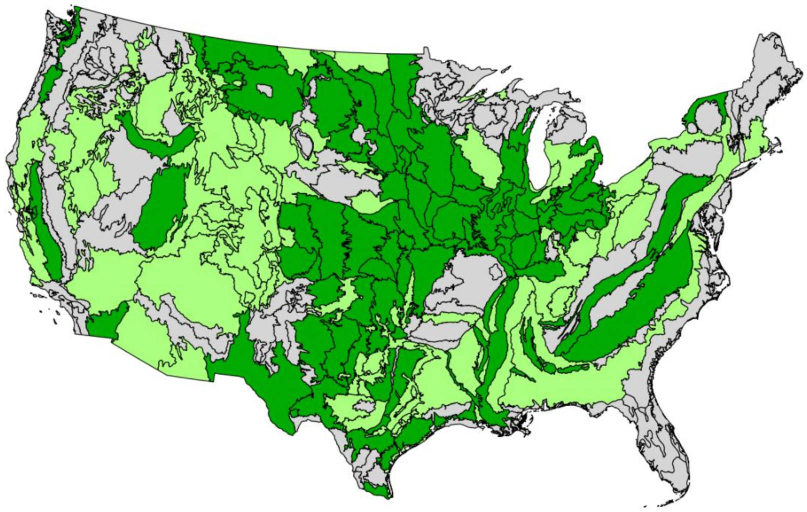

Figure B.1. Map of 10-30 Year Grassland Data Points on Clay Soils

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.

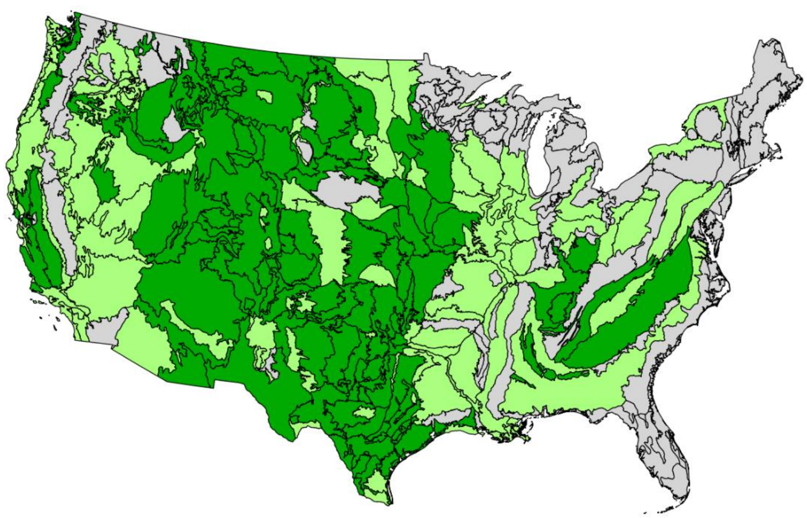

Figure B.2. Map of 30+ Year Grassland Data Points on Clay Soils

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.

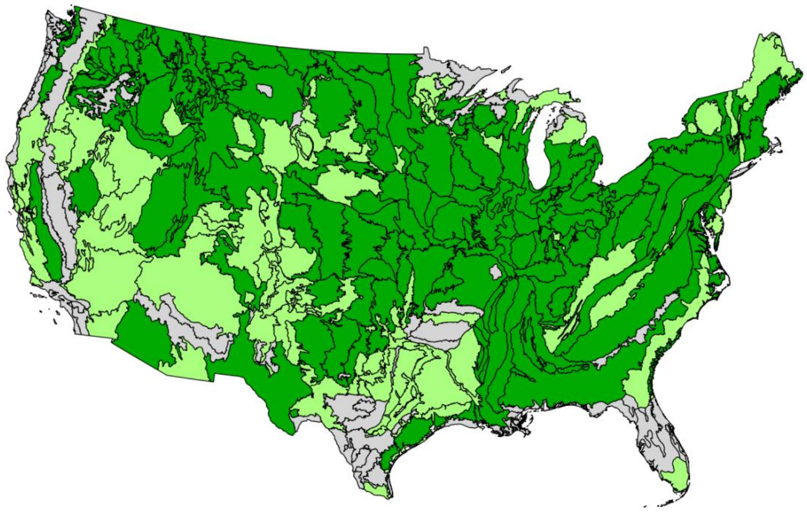

Figure B.3. Map of 10-30 Year Grassland Data Points on Loam Soils

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.

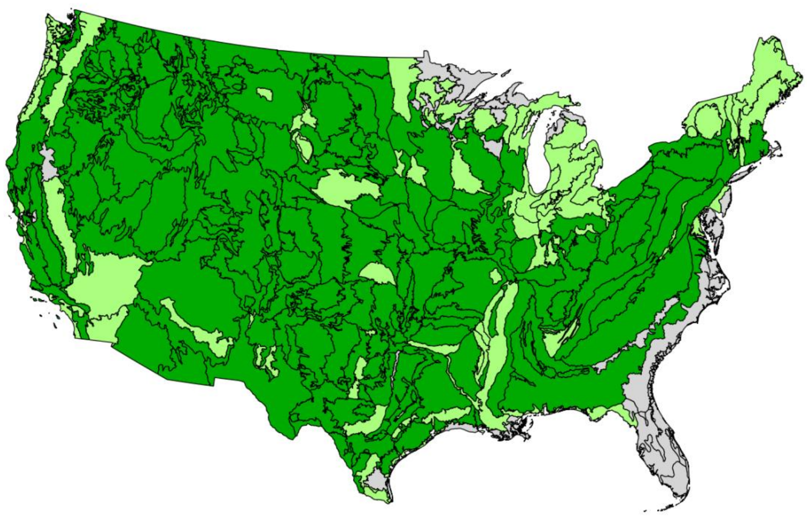

Figure B.4. Map of 30+ Year Grassland Data Points on Loam Soils

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.

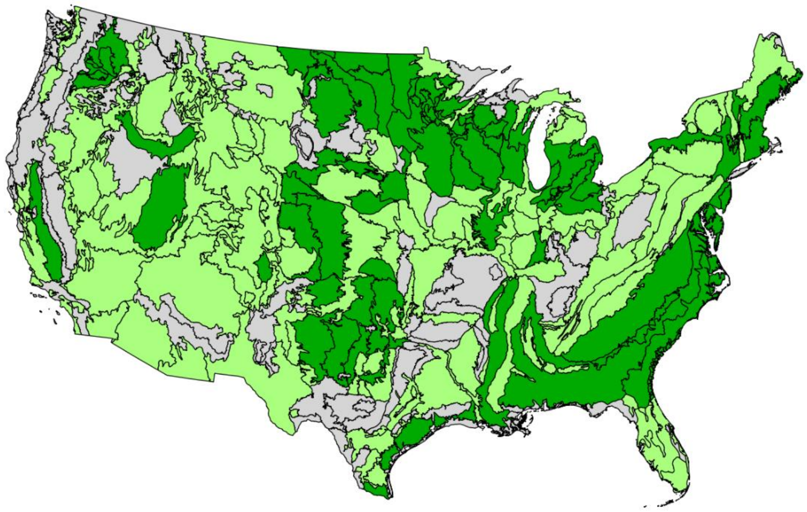

Figure B.5. Map of 10-30 Year Grassland Data Points on Sand Soils
Grey represents 10 or fewer points. Light green represents 11-100, and dark green represents greater than 100 data points. Emission rates have been provided for all green MLRAs.

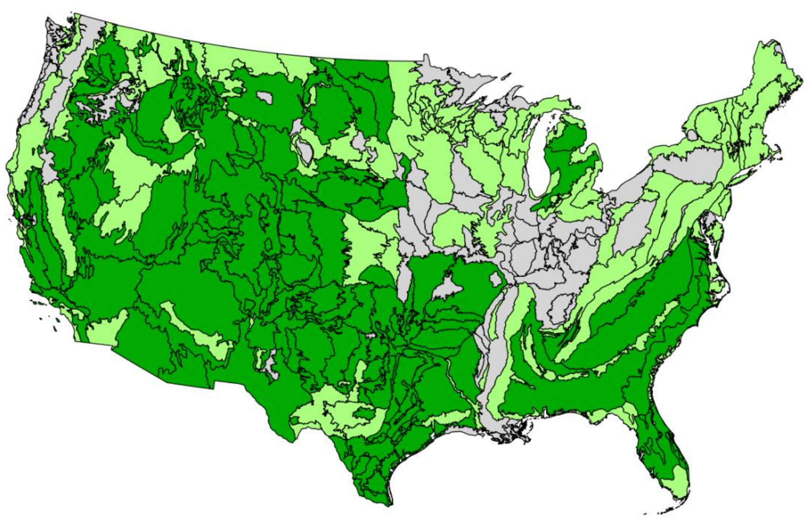

Figure B.6. Map of 30+ Year Grassland Data Points on Sand Soils
Grey represents 10 or fewer points. Light green represents 11-100, and dark green represents greater than 100 data points. Emission rates have been provided for all green MLRAs.

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.[8] 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.[84]
- **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)[85], 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.[86] 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 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

[84] USDA Economic Research Service (2010) *"No-Till" Farming is a Growing Practice*, available at: http://www.ers.usda.gov/media/135329/eib70.pdf
[85] USDA Economic Research Service (2013) *Fertilizer Use and Price*, available at: http://www.ers.usda.gov/data-products/fertilizer-use-and-price.aspx
[86] 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.

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[87]

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

[87] 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)[88,89]	MCF Value for Pasture/Range/Paddock Manure Management[90]
-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	

[88] 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.
[89] 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.
[90] 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[91]	0.48 [a]	0.344 [c]	0.034 [c]	0.0041 [e]
Poultry[92]	0.39 [a]	0.058 [c]	0.002 [c]	0

Sources:
[a] Environmental Protection Agency (EPA). U.S. Inventory of GHG Sources and Sinks 1990-2012 (2014), Annex 3, Table A-203.
[b] Adapted from Environmental Protection Agency (EPA). U.S. Inventory of GHG Sources and Sinks 1990-2012 (2014), Annex 3, Table A-205.
[c] Adapted from Environmental Protection Agency (EPA). U.S. Inventory of GHG Sources and Sinks 1990-2012 (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] Environmental Protection Agency (EPA). U.S. Inventory of GHG Sources and Sinks 1990-2012 (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)[93]

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

[91] The manure characteristics for swine are represented by an average of the values for different swine weight categories.
[92] The manure characteristics for poultry are represented by the values for turkeys.
[93] 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
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
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)[94]

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

[94] 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 US 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

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.[95] 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 0.12 to represent direct emissions and emissions from the volatilization of fertilizer. This value is derived thusly:

$$A = B + (C \times D)$$

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:

$$Leach = E \times F$$

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:

$$G = H + (I \times J)$$

[95] 2006 IPCC Guidelines for Greenhouse Gas Inventories, Chapter 11, Table 11.3.

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.

Appendix D Example Project Area Map

[Insert image file with example GIS map of a fictional project area]